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Ex-Secretary Humphreys' Acknowledgment.

CHESTNUT HILL, PA., NOV. 4, 1891.

To the Editor AMERICAN GAS LIGHT JOURNAL:

Will you kindly permit me to reach through your columns my good friends in the American Gas Light Association, who recently surprised and delighted me with the casket of beautiful and precious silver now before me, and supplemented this handsome testimonial by presenting me with a life membership in the Association.

I trust my friends will accept the assurance of my most hearty gratitude for this mark of their esteem. That my efforts to make pleasant and profitable the meetings of our Association while I was in office should have met with such a beautiful and valuable reward, is due, I feel, rather to the over-appreciation of my friends than to the worth of my work.

The finely wrought and artistically designed silver will be an ever-present and constant reminder of the many pleasant associations connected with my eight years of service, and an ever-welcome token of the numerous friendships formed during that time—friendships as solid as the silver before me, and as beautiful and bright to the memory as is this casket to the eye.

That the life-work of my friends will meet with that solid and feeling mark of appreciation and esteem that they have so freely granted me is my earnest and heartfelt wish. Sincerely yours,

C. J. R. HUMPHREYS.

BRIEFLY TOLD.

THE ASSOCIATION PROCEEDINGS.—In this number we print a second installment of the proceedings of the last meeting of the American Gas Light Association, the current publication containing the paper on "Leakage," by Mr. C. H. Nettleton, of Birmingham, Conn., and the discussion that followed its presentation. That the installment is so small is solely to be accounted for on the ground that the copy was not received at our office until 10 o'clock A. M. of Thursday, the 5th inst. As we go to press on the afternoon of each Friday, and as the resources of our composing room are not equal to those of a metropolitan daily newspaper, we take some credit to ourselves for having succeeded in putting before our readers the portion that we did. The "copy" was forwarded from Philadelphia per United States Express, on the evening of Tuesday, November 3, and should have been in our hands at an early hour of Wednesday. Unfortunately the package was directed to 42 Pine street, instead of 32, and as the driver of the delivery wagon, on making his rounds, was confronted at 42 with the yawning openings of an embryo building, the walls of which were not much more than half way up to their ultimate elevation, he decided evidently that the JOURNAL was no longer "in" the street. At any rate, knowing that the package had been forwarded, inquiry at the main office of the Express Company proved that our "copy" was at some point of the city in charge of the wagon driver, so there was nothing for it but to wait. Thus, between the inadvertence of the sender at Philadelphia and the stolidity of the expressman, we were baulked of our wish to print a goodly portion of the proceedings in this issue. The registered mail we have always found to be the speediest and safest way of transmitting or receiving "copy;" but sufficient in explanation would seem to have been said.

MR. NETTLETON'S PAPER.—It has been a matter of common knowledge for some time that Mr. Nettleton never goes at a thing without a thoroughly good understanding of what he is about, and that what he puts forward as his opinion respecting the matter that he has investigated, is the result of mature deliberation, and stands for his own guidance. Strangely enough, another earlier paper that was widely and favorably commented on at the time, was read by Mr. Nettleton at the meeting in New York (1887), prior to the last one—his admirable contribution at that time having been on the subject of the utilization of residual products. He then showed that in a place of the size of Bir-

mingham, Connecticut, with the conditions there not more favorable to the gas maker than those obtaining in like average situations elsewhere, it was possible by shrewd management and "everlasting effort" to cause the residuals of coal gas manufacture to yield a return equal to 70 per cent. of the cost of the coal carbonized. Many were disinclined to accept that statement, without reservation, but his figures were plain, and another equally clear fact was that his profit and loss account reflected them in the shape of dollars and cents. In 1891 he presents another hard nut for the cracker, in the matter of a calm statement that his unaccounted-for gas, in the year ended April 1, 1891, on a total make of 43 millions cubic feet, figures out at only 2.7 per cent.

This is approaching the "possible" very closely, and, to say the least, his figures will be scrutinized with that interest which is inspired by wonder. Surely, if "everlasting effort" is to be "the price of small leakage," then Mr. Nettleton, it must be admitted, did not have many idle hours in Birmingham, last year. It is true that the yield per pound (4.77 cubic feet) of coal was low during the time under review, but then it is equally true that in '86, on a make of only 28½ millions, when the yield per pound (4.92) was comparatively high, the leakage account (5.3 per cent.) was far from being abnormal. In fact we imagine that most gas makers would be well satisfied could they attain and sustain an unaccounted-for gas return of 5 to 6 per cent. per annum. The discussion, through its animated tone, shows that Mr. Nettleton's paper aroused the thoughts of the members, and that he evidently had them thinking; and Mr. Addicks' contribution to the dialogue was far from being the least interesting division of it.

The paper is well composed and will be referred to frequently in the twelvemonth by many of his brother managers when they, in the monthly round-up of their work, come to the vexed and vexing matter of apportioning the percentages to go to unaccounted-for gas. Of course, it is simply impossible to even approximate the Birmingham percentage in the large majority of situations in this country—and this is especially so of the larger cities, where upheavals of the roadbeds are the rule, and where the depressions of the surface, from the rumbling activity of commerce, never cease. Situation and circumstance must ever be live factors in settling the unaccounted-for gas account—just as much as they are in determining the cost of gas to its manufacturer.

MR. EDWARD LYONS, formerly at Indianapolis, Ind., has been appointed Superintendent of the Huntsville (Ala.) Gas Light Company, replacing Mr. W. S. Rothell, who resigned.——The Arkansas Coal, Gas, Fireclay and Mfg. Company, has been organized at Hot Springs, Ark. Capital, $200,000.——An effort is being made to place the Pulaski Gas Light Company, of Little Rock, Ark., in the hands of a Receiver.——The Electric-Gas, Light and Power Company has been chartered for Taylor, Texas. Capital, $40,000.

The next meeting of the Gas Club, of Chicago, will be held in about a fortnight. Our next issue will give exact date, place of meeting and programme.

SPECIAL WESTERN CORRESPONDENCE.

By SUNSET.

Dear JOURNAL:—That skilled personal attention is the secret of success in almost any business is true, that it is especially needful in the gas business is even more true, and that it is an absolute necessity for success, and repays many fold, in certain lines of the gas business, is most true. I refer particularly to the management of gas stoves and of leakage. Complaint from easy going superintendents that in this direction they cannot succeed, as their conditions are "peculiar," reminds me of the man who said, when the facts did not agree with his story, "So much the worse for the facts, change 'em." To the dormant superintendent I say, "Change the conditions." What can be done in this way is shown in an instance that lately came under my observation. Place, a town in Michigan of moderate size. Former record, a small output, poor candle power, and no gas stoves—"people didn't want them for cooking, and you couldn't make any impression on that climate with a gas stove." A change of administration brought in a superintendent who flatly declined to believe this last statement. First, a better candle power was given for a lesser price, and then the gas stove business was pushed, pushed—pushed by sheer sticking at it. To-day, *one out of every two* consumers has a gas stove of some sort, and there is *one gas stove to every* 20 of the total persons—men women and children—in the place. For the year '90, nearly 50 per cent. of the total output was sent out in the six months from May to November, and for the current year it is expected that over half the output will be sent out during these summer months, mostly for stove business. There is no electric company in the place, so that loss of store lighting does not conduce to light winter output and these results. That superintendent rather believes that gas is here to stay, and he proposes eventually to have every meter in town represent a stove, even if he has to make some of his consumers double up.

What can be done in leakage, is shown by Mr. Nettleton's paper at your recent American Association meeting, East—a reduction in this item from concentrated sticking at it to less than 3 per cent.! And most companies think themselves fortunate if they have reduced their leakage to twice that amount.

My preaching on this matter of energetic, personal pushing is well supported by a few figures lately reaching me, from a friend who had visited Terre Haute, Ind. Both Companies there, spurred to extra effort by the war between them, and aided by the allurement of 35-cent gas, have experienced an enormous boom in the stove business. 'Tis a hard citizen indeed who can resist the importuning of the agents for business for one or the other of the Companies. Supt. Diall has ceased to reckon or order stoves merely by the dozens. Since the fight commenced, about nine months ago, he has introduced some five *car loads*. Meters have jumped 50 per cent., and his entire output has grown so, without a corresponding increase of fixed charges and expense, that it has very largely helped to lessen the hurt from the competition. So large has the output become that in September (three months before the heavy month of December) his output had topped the record of the works for greatest daily send out. "It seems like pretty severe medicine," says Mr. Diall, "35 cent gas; but our business has increased so that when the competition is over the price will not have to be put back to its former figure, by any means." Meanwhile, how are the contestants holding their own? The old Company, with a thoroughly well equipped coal works and a large modern water gas plant, using its own coke with cheap coal and oil, and high prices for residuals, is putting out, at a minimum of cost, a magnificent, thoroughly fixed, mixed gas of the highest heating value, and 25 candle power.

The Citizens (MacKenzie process) Company is putting out, practically, an oil gas, carrying 15 to 45 per cent. of nitrogen, according to the vagaries of the continued experimental workings of the apparatus. The gas is, as are all oil gases, "heavy" in combustion, lacking "stiffness," and has strong smoking tendencies. Is it any wonder, prices being equal, that the public prefer the old Company's gas, and that it, therefore, is getting all the growth of the business? Of the total meters in town the new Company has but one eighth and is not materially gaining. Its output, claimed to be 100,000, is known to be much less, and ditto, "not gaining." It is hard to comprehend or believe the statement that its proprietors are making money; for those in position to know, without the blindness that comes from ownership or self-interest, tell me that the cost of the gas in the holder is practically equal to the selling rate.

Once again is the earnest and hard working gas engineer sorely tried by the preposterous claims of the "philanthropists." Philanthropists who, rumor has it, offered to stay out of Evansville, Ind., for $15,000, reduced their demands to $7,500, and as yet haven't gotten either it, or into the city. I rather think, too, that the brains of the President of the Ohio Gas Light Association are sufficient to keep them out.

The "MacKenzie process," that is offered as the "whyfore" of the 35-cent gas above named, is easily described. A firebrick lined chamber, filled with checker-brick in imitation of a Lowe superheater, is made hot by burning oil in it, with plenty of air, for combustion. When hot, the air supply is cut down to a point insufficient for combustion; the oil continuing to flow, is vaporized and gasified by the heat from the hot brick, and, diluted with what air *is* admitted, goes off as oil gas, and there you have it.

The gasholder is built of heavy plate iron, double riveted, to give 8 inches pressure. Coupled with the four and one-half million holder now building in Chicago (the largest in the U. S.), and one without guide framing that I hear talked of, the West will soon lead both in size and pronounced design of this part of gas plants.

The Economic is still pegging away, pipe laying.

The Gas Club of Chicago met lately for the first regular meeting. A capital spread was enjoyed, I am told, for a moderate sum, and a thoroughly good time had by all. Uncle Jerry Howard's selection as President was a masterpiece. Unhampered by relations of trade, beloved by every gas man in the West, he will constantly imbue into the Club the sparkle of his own genial personality. F. R. Persons, as Vice-President, and F. H. Shelton as Secretary, were also fitting selections, and a well deserved recognition of the earnest and continued work done by them in organizing the Club.

[Continued from page 621.]

[Official Report—Revised by the Secretary.]

NINETEENTH ANNUAL MEETING OF THE AMERICAN GAS LIGHT ASSOCIATION.

Held at New York, October 21, 22 and 23, 1891.

First Day—October 21—Afternoon Session.

The Association met at 2 P.M.

The President—The order under which we adjourned was that of general business. There seems to be nothing on the desk of the Secretary calling for your attention. Does any member desire to present anything for the consideration of the Association before we take up the discussion of papers? If not we will proceed to the next order of business, which is the reading of papers; and the Chair has the pleasure of announcing that the first paper to be presented to you will be one by Mr. Charles H. Nettleton. It is upon our old friend leakage—an ever interesting topic to us, and undoubtedly it will be treated in a very interesting and exhaustive manner.

Mr. Nettleton (Birmingham, Conn.) then read the following paper on

LEAKAGE.

In presenting a paper on the subject of leakage, I do not expect to say anything startling, or to add very much to the stock of knowledge already possessed by the members of this Association, but as the subject is one that, "like the poor, is with us always," and is one in which every gas manager is interested, I hope that my paper may not fall entirely on deaf ears.

The cost of gas is made up of so many items, that it is perhaps difficult to say which is the most important. The coal, the oil, the labor, the leakage, the office—they are all important, and care and attention should be given to each, but to no one item to the neglect of the others.

There used to be a saying current among gas men 20 years ago, that I have not heard so frequently in recent years, and that was "that the money was made or lost in the retort house;" but times have changed, and now in many companies a larger part of the cost of gas is outside the gas works yard, and "distribution" is as important, and in some cases more important, than "manufacture." In calling your attention to one of the items of distribution, "leakage," I am sure you will all agree that it is of sufficient importance to receive a portion of the time of every gas manager.

By the term leakage, I mean the difference between the gas registered at the station meter and the amount for which we make out gas bills, plus the quantity consumed at works, offices, etc., in other words, the unaccounted-for gas.

The causes for the difference between the gas we make and the gas registered by consumer's meters are numerous, and some of them I propose to consider at length.

Temperature.—One of these causes over which we can have but little control, and to which I think but little attention has been paid, is the difference in temperature at which the gas is measured at the gas works, and that at the consumer's meter. A friend of mine tested the temperature of the gas for a year, in New York city, at the station meter of the works in his charge and at the meter in his own house, and the average difference was nearly 16°. In this case the house meter was in the cellar. Allowing for meters kept in warmer places, such as factories, stores, etc., it is probably safe to say that in this latitude the difference in temperature of gas when made and when sold is not far from 10°, and as every 480 feet of gas expands or contracts about 1 foot for each increase or decrease of 1° in the thermometer, it follows that for the estimated 10° the contraction is 2 per cent., so that of our apparent loss of 5 or 10 per cent., about two parts are beyond our control.

Leaks in Mains.—The main source of loss, however, is probably leaks in mains and services.

Thanks to the energy and ability of the men who make our pipe today, we have, whether using cast iron, wrought iron or steel, an uniformly good pipe, in using which, with reasonable care, good joints can easily be made. The younger men in the business will never know, unless they happen to use some ancient "special," the annoyance and bad language that were produced years ago, by the spigot end of some fitting being too large for the hub of some pipe of the same nominal size, though both pipe and special, perhaps, came from the same foundry, or when, in regular hub and spigot pipe, the space for a joint was only one-eighth of an inch in width. With such pipe it was very difficult to make good joints, and consequently difficult to keep down the leakage.

I am unable to speak from personal knowledge of the use of wrought iron or steel pipe as mains, but those who have used that kind speak highly of it, particularly in connection with its freedom from leaks. The company with which I am connected have nothing but hub and spigot cast iron mains, and as they, in this section of the country, are used almost exclusively, I propose to confine my remarks to them alone. Owing to the heavy water pressure put upon all cast iron pipes at the foundry where made, the pipes when first purchased, are almost certain to be without cracks or holes, and when laid, and the joints well made with either a good soft lead or Roman or Portland cement, one is reasonably sure of having a tight pipe before the ditch is filled.

In regard to material used in making joints; personally, I prefer those made of cement, on the score of much less cost, and less liability to leak. A personal experience, which is no doubt familiar to many of you in your own work, will best illustrate my faith in cement joints. In a severe winter, several years ago, the frost had gone down around a six inch gas pipe on a certain street, and a large leak was reported in that neighborhood. On digging up the pipe it was found to have pulled apart three-eighths of an inch where tapped for a three-quarter inch pipe, and a cement hub and spigot joint, less than three feet away, was intact. I think the chances are that with a lead joint the latter would have drawn, and a leak started which would not have been stopped until the "smelling committee" (as named by one of our local papers) had put in its work. But either lead or cement with well driven gaskets makes a first class joint.

The filling of the ditch as far as the top of the pipe is a very important matter, and too much care cannot be taken up to that point. Crooked rammers should be used to pack the dirt firmly and solidly under the pipe, so as to give it as solid a foundation as possible. But in doing this, care is needed, particularly with small pipes, to see that the dirt is not rammed too vigorously, thus raising the pipe out of line and making the first start toward leaky joints. I desire to emphasize this point, as I believe as much, or more, depends on the way the ditch is filled, as on the way the joints are made. Another personal experience may illustrate this.

About twelve years ago, when knowledge seemed to be much larger in quantity with the speaker than at the present time, I had occasion to lay about 8,000 feet of 8-inch pipe. It was rushed through, and the cost per foot was satisfactorily small, the gas was turned on, and tested by means of a meter and valve. To my surprise and mortification the gas was going through the meter rapidly, although not a consumer was on the main. Some of the leaks were soon found and stopped, but the pipe could not be made satisfactorily tight at once. Afterwards I found out that in the hurry of getting in so many lengths of pipe per day, that, in certain sections, the dirt had not been properly rammed under the pipe. For nearly three years after it was laid it was a source of great annoyance and expense, but finally, with the ramming that each length received when a leak was repaired, the trouble disappeared and to day it is as tight as any other length of main under my control. But while the trouble lasted I believe it is no exaggeration to say that more than 500 leaks were repaired on that line of pipe. Since that time my attention in laying pipe has been given principally to packing the dirt under and around the pipe.

Kind of Soil.—The quantity of leakage depends to a considerable extent on the character of the soil surrounding the pipes. Given, a sandy or gravel soil, and the passage of the gas from the pipe through a hole or a cracked joint is hindered very little by the surrounding dirt; loam lessens the leak materially, and stiff wet clay makes the pipes tight, holes and cracks to the contrary notwithstanding.

In a certain city in which the gas pipes are surrounded by mud, through which the gas cannot be forced by the ordinary pressure, I was told that the leakage was absolute nothing except the gas lost in making connections with services, laying new mains, etc.

In this connection it may not be out of place to describe the method followed by the speaker in searching for leaks. The gang is made up of a foreman and either eight or ten men. The foreman from his book containing the location of pipes, lays out the line of pipe, indicating same in any convenient manner. Along this line, when on unpaved streets, a man makes holes every 6 or 8 feet through the crust of the road with some light, pointed iron bar, generally a piece of 1-inch pipe with a steel point at one end.

Following him come six or eight men in couples, each with an 8-pound striking hammer, and each couple with a steel bar about 3 feet 6 inches long, having one end drawn out to a long, sharp, tapering point. In the shallow holes made by the man in advance, these steel bars are driven, each bar being struck by two hammers. When driven from 2 to 3 feet, the distance varying with the known depth of the pipe, the bar is hammered sideways, and then is easily withdrawn by hand.

The two men take their bar and go forward immediately to drive another hole.

Following these is another man whose sole business is to smell at the openings made by the bars, and then fill in the same with loose dirt, reporting all leaks to the foreman.

On paved streets, the same bar is used for a short distance to separate the paving blocks, and then a smaller bar is driven down to the main. So much difficulty was found, however, in withdrawing the bars on paved streets, that to save time a tool was made, which, while crude, works well. A heavy bar with jaws on one end is used as a lever, a piece of hard wood cut on its edge into steps, the latter shod with iron plates, is used as a fulcrum, and the bar pried out. This simple device nearly doubled the amount of work that could be done on paved streets with a given amount of labor, as compared with withdrawing the bars by hand.

The above system is the result of many experiments through a series of years, and while it may not answer in all places, yet with the soil in my neighborhood, which is largely sand and gravel, it works very well.

Services.—With leaks in services, I have had very little experience; but I am told that in older companies than mine, and in those where the soil rusts wrought iron quickly, this is a large source of loss.

It is said that this destruction can be prevented by coating the pipe with one or more preparations, but of that I cannot speak of my own knowledge. Certainly, if troubled from this source, I would try to see that the services were so coated that little or no rust would form.

Consumers' Meters.—Another cause of unaccounted-for gas is the errors in consumers' meters, for which I think the only remedy is periodical testing. If a company does not test its meters for years, some of them are bound to get out of order, the bellows gradually lose their oil, do not expand to their full capacity, and the meters run fast, or the bellows are cracked, the valves or their seats wear unevenly, and the meter runs slow.

The fast meters, when they become fast enough, are sure to be heard from, by reason of complaints from consumers, are brought in, tested, and correct meters substituted; but the slow meters are rarely heard from, generally not until they fail entirely to register. In this way, and for these reasons, a company failing to test its meters will in time have a large majority running slow; and I am confident, after testing all my meters a number of times, and knowing how many run fast and how many run slow, even when repaired every three or four years, that it is only a question of a few years before 7 per cent., or even more, of all gas sent out would become "unaccounted for" by reason of slow consumers' meters.

This is one reason, but not the only one, why it pays to test meters periodically.

Station Meters.—Another cause of loss is an incorrect station meter. How general this is I am unable to say, but more than once when hearing some wonderful tale of big yields per pound I have wondered if the station meter on which these results were based was correct. I have heard it stated that very large yields and very large leakage were quite apt to go together. But in this matter, as in many others, it is very easy to deceive oneself, and tests should be made occasionally to demonstrate the fact that the meter is approximately correct.

The following table has been prepared with care, and gives the results obtained at the works in my charge for the past 10 years.

Year Ending.	Gas Sent Out.	Unaccounted For.	Per Cent.	Miles of Pipes. Approximate.	Sent Out per Mile per Year.	Lost per Mile per Year.	Total Cost of Searching & Stopping Leaks.	Cost per Mile per Year.	Yield per lb. of Coal.
Apr. 1, '82	20,503,040	1,879,082	9.1	9.4	2,181,174	199,902	$862 23	$91 72	4.72
" '83	24,331,210	2,007,518	8.2	10.6	2,295,397	189,388	273 21	25 77	4.90
" '84	27,770,260	2,659,308	9.5	11.8	2,353,412	225,365	285 64	24 21	4.87
" '85	26,471,990	2,216,838	8.3	12.2	2,169,835	181,708	481 20	39 36	4.93
" '86	28,332,044	1,496,123	5.3	14.3	1,981,262	104,624	395 63	27 66	4.92
" '87	30,107,386	1,539,296	5.1	14.8	2,034,350	104,006	609 79	41 20	4.74
" '88	33,268,912	1,533,448	4.6	15.3	2,174,439	100,225	22 74	1 48	4.91
" '89	34,851,118	1,859,938	5.3	15.8	2,205,767	117,718	531 04	33 61	4.89
" '90	38,910,268	1,679,948	4.3	16.7	2,329,956	100,595	243 42	14 57	4.85
" '91	43,001,890	1,154,021	2.7	16.9	2,545,490	68,285	370 61	21 93	4.77

The first column is the gas sent out for the several years, as stated.

The second column, the unaccounted for gas expressed in feet.

The third column, the unaccounted for gas expressed in percentage of the total send out.

The fourth column, the miles of pipe. I regret to say that the figures for the first few years are not absolutely accurate. The errors, however, I believe to be slight. The figures for the last four years are correct.

The fifth column, gas sent out per mile of pipe per year.

The sixth column, the loss per mile of pipe per year. This probably expresses leakage in the fairest way possible, for the purpose of comparison with other works; and yet given a works with a consumption of 10,000,000 per mile, and the loss due to difference in temperature at which gas is measured at works, and in consumers' houses, would probably be nearly 200,000 feet per mile. For the average sized works, however, under 100,000,000 per year, and sending out between 1 and 1½ and 3 millions per mile of pipe per year, I suggest that no fairer basis of comparison can be made than the feet lost per mile per year.

It was suggested a few years since that the size of pipe ought to be considered; that on a 12 inch pipe the chances of a leak were just double that on a 6 inch, owing to the greater area of pipe and joint. But all smaller works will average about the same sized pipes, and to figure everything to a basis of say 4 inch pipe, is a refinement that, in my judgment, is uncalled for. I am quite well satisfied that for small works 100,000 to 150,000 feet per mile per year should be considered a reasonable amount of leakage, and unless the circumstances were exceptional, a manager should not rest satisfied until that figure was reached.

Seventh and eighth columns give total cost and cost per mile respectively, of searching for and stopping leaks. These columns are added to add general interest to the table, and in the hope that the discussion will bring out the fact that the costs stated are above or below the average cost in other places.

I desire to call your attention to the fact that in the year ending April 1st, 1888, but $22 was charged to leakage, but in the year following, quite a large amount was spent, and yet the leakage increased, showing the lack of attention in the previous year.

The ninth column is added so that it cannot be suggested that if the yield per pound of coal had been given the table might have assumed a different appearance. It is but fair to state that these yields are reached after adding 2 per cent. to the weight of coal carbonized. Your attention is called to the lower yield for year ending April 1st, 1891, and the small leakage in the same year. I think it is entirely probable that if the yield for the last year had been larger, that the unaccounted for gas would not have been so small as reported.

In closing this paper I venture the opinion that like many lines of work it requires only patience and perseverance to make a success with the leakage problem.

Regular attention, the same we give to our manufacturing operations, through a series of years, will certainly bring the desired result. But when once reduced it will not do to assume that the leakage will remain small; the laws of nature are constantly working in a way that must produce leaks sooner or later, and if no attention be paid to mains for two or three years the leakage will surely increase no matter how small at the commencement.

I heard one of the best known and most successful lawyers of this country say, that the conditions of success in his profession were a good stomach, a willingness to work, and a very moderate amount of brains. However much one may be inclined to take the remark, *cum grano salis*, as applied to the legal profession, there can be no question as to its truth when applied to successful work on leakage.

A good stomach—health to attend to the work, and strength to do it.

A willingness to work—industry and perseverance, a determination to reach the goal you have set for yourself, if work will accomplish it.

A moderate amount of brains—I have yet to discover the need of any considerable ability in trying to reduce leakage. We are all, the brightest man and the dullest, on about the same level when it comes to the treatment of this question.

Work, and work alone, is nearly all that is required. "Eternal

vigilance is the price of liberty." Everlasting effort, the price of small leakage.

Discussion.

The President—You have heard, I have no doubt, with great pleasure, the reading of this very bright and capable paper. If any gentleman wishes to ask any question on the subject, I am sure that Mr. Nettleton is prepared to answer. The Chair desires to have some discussion on this very important question.

Mr. A. E. Boardman—I would like to ask Mr. Nettleton why he adds 2 per cent. to his total weight of coal in estimating his yield. Is it because he finds that more is used, and that that is the amount of error; or is it a custom in that section of the country?

Mr. C. H. Nettleton—Before I added a percentage to the quantity of coal actually weighed into the retort the coal pile ran short each year. I think I commenced by adding 1 per cent., but found that that was not enough; I then added 2 per cent.; and the last time I balanced the coal the error was a very small fraction of 1 per cent. I presume the shrinkage comes in the amount of water contained in the coal, which evaporates before the coal is used; and also is due to errors which the retort house men are bound to make in weighing in the coal. This practice I have continued for about ten years.

Mr. A. E. Boardman—I asked this question purposely in order to bring out that statement. I think that most of us have experienced a difficulty in making our coal account balance; but I find, contrary to the experience of Mr. Nettleton, that my coal pile is apt to be over rather than under weight owing to the fact that my retort house men will fill up the barrow, weigh it on the scale, and then if their heats are a little low they will leave off a shovel or two, and that shovel or two of coal goes back on the scale and is weighed. So that at the end of the year I really have more coal than I ought to have. I am glad to find that Mr. Nettleton's men are a little more conscientious.

Mr. J. F. Scriver—I think that Mr. Nettleton is to be congratulated on his very low percentage of leakage. I think that most gas men present would feel somewhat envious of Mr. Nettleton's results. But there is one very fruitful and frequent source of leakage to which Mr. Nettleton has not referred in his admirable paper, and that is the one of condensation. With us who are further north, I think that is one of the greatest sources of unaccounted for gas. The question of condensation is a very serious one with us, and one which we cannot, of course, according to the nature of events, overcome. I would like to hear from Mr. Nettleton whether he is troubled at all with condensation in his pipes.

Mr. C. H. Nettleton—I shall have to ask Mr. Scriver just what he means by condensation. Do I understand him to include in that the difference in temperature at which the gas is measured by the meter at the works, and the temperature at which it is measured at the consumer's meter? Is not that the principal source of what is called "condensation?" Of course, there are some liquids which condense out of the gas, which undoubtedly exist there in the form of vapor and which were measured at the station meter; but I think that is but a small part of the condensation. I pump very little out of my mains. The drips, except a few near the works, are pumped only once a year, and the quantity obtained is not large. I think that the principal condensation is due to the difference in temperatures between which the gas is measured at the works and that at which it is measured at the consumer's meter. I may be wrong, however, in that idea.

Mr. T. Littlehales—I would like to ask Mr. Nettleton for his experience as to gas passing through large meters. In my own experience, in the case of a large number of dry meters of large size, say 50, 80 or 100 light meters, where they let one or two burners go all night, I have found a very marked source of leakage from that cause. Gentlemen will readily recognize that fact when they recall that the slightest bit of corrosion, or if a particle of dust gets under the valves, leaves a very large area open for the gas to escape. As an illustration of that, I took out a 50 light meter not long ago, and with three lights only it would not register a foot; with five lights it was 75 per cent. slow, but yet with 50 lights going it was practically correct. I am perfectly satisfied that in a great many cases where we have large meters, with one or two lights going all night, we loose a great deal from that source. It is important to know if anything can be done to obviate that difficulty.

Mr. C. H. Nettleton—I try to avoid that trouble, which is bound to occur with many large meters by bringing in and testing every large meter we have once a year. I think in that way we avoid much of the loss due to non-registration. All my meters are ordinarily tested every three years, but all the large meters and all meters in factories where there is a large consumption, are tested every year.

Mr. T. Littlehales—You have found that error frequently to occur, have you?

Mr. C. H. Nettleton—Yes.

Mr. W. H. Pearson—I was under the impression that we were losing a great deal of gas from the source that Mr. Littlehales has just referred to, but about a year since I sent an inspector to every place where there was a large meter and had, I should suppose, 400 or 500 of these meters examined, and tested with a single light, and I found that out of that number there were not six meters which would not register with one light. I must confess that I was very much surprised at the result of that test. I expected a very different result. I do not now think that there is very much gas lost from that cause.

Mr. Geo. B. Neal—When the Chair called for remarks from members upon this subject, I thought that all the members present would rise to their feet, and that it would be impossible to hear and understand what anyone said, for there would be so many talking at once. But, when there was a pause I began to think that most of the leakage experienced in other companies was very small—but a trifle in fact. In the company which I represent, the Charlestown Gas Company, we have had a leakage year after year, and I have made the greatest exertion to find where those leaks were, and to stop them. With that end in view I have used meters with a good many valves and by-passes; but the leakage does not go down. I should not be quite so sensitive on that subject but for the fact that under the laws of Massachusetts I am required to make a report, and which report is read all over the country. In fact I understand that the reports of the Commissioners are considered such interesting reading that they are sent all over the civilized world. We have one of the Commissioners here to day, and he can corroborate my statement. These reports are, indeed, very interesting reading. In New England we have to show our candle power; and it is very unpleasant for me to see in print the statement which I have to make that the leakage is 10 or 12 per cent., as the case may be. I have tried my best to reduce the amount of leakage, but have not succeeded. So far as testing meters is concerned, I think that the average of those that are sent to the inspector for testing are very nearly correct. Many are slow, and as many are fast. Some time ago the leakage in one quarter came down 33 per cent., but I was not conscious that any leaks had been stopped. We had done nothing in particular to cause that change. This last quarter, from April to July, there was the same diminution in the amount of leakage—about 33 per cent., and I cannot account for it in any possible way. I wish that the gentleman who read the paper could have suggested some remedy, some strong remedy, that we might apply in a very violent way, by which we could reduce that leakage. I do not think that it is caused by excessive measurement on the part of the station meter. In fact I am very sure that it is not, because last year, during most of the year, the yield was not five feet per pound. I think that this is not the trouble. I am satisfied of this, however, that sometimes it is owing to leakage in the joints where the spigot end is too large. That happened to me some years ago in a 12-inch pipe that was extended about a mile. We had leakage after leakage from that cause. But that was all stopped. We have two districts, one of which is composed mostly of consumers in dwelling houses, and there the leakage is comparatively small; but in Charlestown the leakage is quite large. There is one point as to which I do not quite agree with the writer, that condensation is greater in cold weather. I do not know as that has been stated exactly that way, but as I understand it that is what is meant to be implied. I do not see but what the condensation with us is about the same in summer as in winter. Supposing the gas was delivered at a given temperature, and was measured at the station meter and then delivered at the consumer's meter at the same temperature, do you think there would be no loss in that respect from shrinkage in volume? But, suppose that we allow the two per cent. which you have allowed, and then after passing the gas through the consumer's meter, let us pass it through another meter, and then raise the temperature to what it was in the station meter—would there then be any loss from that source?

Mr. C. H. Nettleton—But little or none. Of course what is pumped out of the pipe represents so much lost.

Mr. Geo. B. Neal—I thought that you would reply that the gas in passing through the station meter occupies a certain volume, and then when it gets to the consumer's meter it is colder, and that the same gas exactly shrinks in volume. There is no condensation there, is there? I think there is not, because as soon as you restore it to the same temperature it was in the station meter it again occupies the same volume that it did before.

Mr. C. H. Nettleton—It depends upon what you mean by "condensation."

Mr. Geo. B. Neal—Condensation, as we all understand it, is where

some of the gas is deposited in a liquid form in the drips. I wish some remedy could be devised for that. The Charlestown Gas Company suffers from that, and greatly to the injury of its reputation, because everybody reads that report, in spite of all my efforts to the contrary. I think Mr. Miller has tried very successfully this plan of testing meters at the residences of consumers—not taking the meter away, but having them tested at the house. I would like to hear from him on that subject.

Mr. A. S. Miller—I think when the gas leaves the station meter it is practically saturated with watery vapor, and so for each degree of contraction the diminution in volume would be very much greater than in the case of perfect gas, and that there would be a very large amount—not of shrinkage, as Mr. Nettleton puts it, but of actual condensation of the liquor. So that if you pass it through your consumer's meter 10° below the temperature at which it passes through the station meter, then heat it up 10° again, and then put it through another meter, you would not get all the volume, by a good deal, that you had to begin with. Of course, there is a great deal of actual condensation whenever the tem perature is reduced. Another thing: My experience has not been with a great many station meters, but I have found when a station meter is tested by running through 300 or 400 feet per hour, the water line being very carefully kept constant, and then put into use at anything like its full capacity, the motion of the meter would run the water out, or overflow it, and although the water would show high on the glass, yet if you stop the exhauster and allow everything to become normal the water in the meter would actually show below the correct water line as shown by the gauge. In other words, the pressure of the gas inside of the drum would throw the water out of it, piling it high up on the outside, and leaving it low inside the drum. The water would apparently be high, and yet the meter would be registering slow.

Mr. A. E. Boardman—While on the subject of discrepancies between consumers' meters and station meters, I want to call attention to something which has occurred to me. Before saying this, however, I would state I think we are in error when we try to calculate or estimate that condensation of watery vapor out of the gas changes its volume much. I do not think that the watery vapor contained in gas adds greatly to its volume. I think the molecules of water occupy almost exactly the same space and lie between the molecules of gas. So that condensing and taking out the liquids would not reduce the quantity of gas under a given temperature to that degree that we usually imagine. In regard to station meters and consumers' meters, I would call your attention to the fact that in a large majority of cases the gas as measured in your station meter is under 2½ to 5 inches pressure, while it is distributed to your consumers' meters under a pressure of from ½ inch to 1½ inches.

Mr. Wm. McDonald—I would like to ask Mr. Boardman if he has ever figured the amount of the percentage of difference there would be between gas at 1½ inches pressure and at 5 inches pressure.

Mr. A. E. Boardman—I have not figured it.

Mr. Wm. McDonald—Just figure it sometime.

Mr. A. S. Miller—I cannot go deeply into the subject of watery vapor, but Mr. Boardman will find it worked out in the second volume of "King's Treatise," and that will convince him that the presence of watery vapor in gas does make a very great difference.

Mr. A. G. Glasgow—About this matter of vapor condensation: The fact that gas containing aqueous vapor occupies a larger volume than the same gas desiccated can be readily demonstrated in the following way: Into a vessel containing perfectly dry gas at, say, atmospheric pressure, inject a quantity of water, not exceeding that necessary to saturate the gas. The whole of the water will vaporize, and will, therefore, as water, occupy no volume; but the pressure within the vessel will rise above atmospheric, showing a corresponding increase in the volume of the gas and vapor. This is a standard experiment in physical laboratories. Mr. Nettleton, in his paper, has made some observations upon main laying. With one of these I do not find myself in sympathy. He lays especial stress upon the importance of thoroughly ramming the earth back *under* the pipes. If you excavate the earth below the line of the bottom of the pipe you should certainly ram it back as carefully as possible; but why make this needless excavation? It has never been clear to me why so many people, in laying mains, habitually dig the trench deeper by 6 or 8 inches than the pipe is to go, then raise the pipe to its approximate elevation by throwing loose dirt under its bell end, bringing it to its true grade by dropping its free end several times upon this little pile of earth. Such a method not only entails the needless cost of excavating and refilling this additional earth, but, what is of even more consequence, the pipe is resting upon what may, to a certain extent, be called "made" ground. During my connection with a growing Western city we laid a great many miles of pipe, from 24 inches to 4 inches in size, and followed the invariable custom of grading the bottom of the trench to receive the pipe fair upon it—with the exception of the carefully located excavation of the joints—thereby saving money and doing a better job.

Mr. W. P. Fodell—Wth reference to this matter of filling, I may say in our case it has been the habit to lay a piece of plank under the pipe, on solid ground, and then the earth is filled in around without any tamping. With reference to the kind of soil, I may say we find that a pipe laid in gravelly soil oxidizes very rapidly, whereas pipe laid in loamy soil (where the loam touches the pipe) is almost as good as new when it is uncovered after a long period. With regard to meters, I may say when we find that a man's bill is gradually getting smaller we change his meter, and then we ordinarily find his bill going up to the usual amount. In regard to condensation, we take the temperature of the gas as it leaves the station meter, and also take it at the extreme end of the district, and find that the difference in temperature is so small that the percentage is hardly worth mentioning.

Mr. Geo. T. Thompson—If a long discussion is any criterion of the value of a paper, Mr. Nettleton must be much gratified. Before the discussion is closed I should like to ask him a question. Does he have any system of districting by which he can localize his leakage, or does he simply distribute the leakage over the entire area?

Mr. C. H. Nettleton—I have for several years gone over all the pipes. Some ten years ago in certain districts valves were inserted, and then the mains were tested by shutting off certain lines and passing gas into them through a meter. But as the number of consumers has increased it has become unsatisfactory; for it was uncertain, in putting a meter on a certain length of pipe, that there were not one or more burners going, or that there were not one or more gas stoves in use. I presume my experience is similar to that of other people in that respect.

Mr. F. W. Gates—How often do you think it is advisable to go over your mains? For instance, if you make an examination this year, what interval would you think it safe to allow before you examine them again?

Mr. C. H. Nettleton—I now go over the mains once every year. When the leakage was up to 9 or 10 per cent. I went over them twice generally in one year.

Mr. James Somerville—This statement by Mr. Nettleton of 2.7 per cent. ioss by leakage seems to be so extreme that I would like to hear a little more about it. When I got my leakage down to 7 per cent. I thought I was doing remarkably well. Is it all coal gas that you make?

Mr. C. H. Nettleton—Yes.

Mr. James Somerville—Do you have many public lamps?

Mr. C. H. Nettleton—None at all.

Mr. Somerville—Do you bring your gas to a standard temperature?

Mr. C. H. Nettleton—No; we do not. In winter the temperature is about 60°. In summer the temperature is that of the surrounding air, and probably averages between 70° and 80°.

Mr. James Somerville—A difference between the station meter and the consumer's meter of 2 per cent. is practically no leakage at all, as it seems to me. This reminds me of some one here who once stated at one of our meetings that he sent out more gas than he made. I remember that George Anderson, a London gas engineer, in speaking of this very subject of leakage, stated he was supplying a large quantity of gas to the authorities, that he measured his gas from the station meter into the holder and charged for the gas so measured, but the authorities rejected that measurement and ordered him to put a station meter outside of his works, declaring they would only pay for gas as measured through that meter. He complied with the request—he had to do it—and the difference between the two meters in that short space was 5 per cent. Between the meter in the works and the meter outside of the works there was a loss of 5 per cent. I think you might well put in another 2 per cent. as the difference between the station meter and the consumer's meters. Thus you would have about 7 per cent. of unaccounted-for gas. Now, there is always some leakage going on. I have often amused myself with my specific gravity apparatus by laying my glass globe right upon the scale. This glass globe is as empty as human ingenuity can make it, and yet in a few minutes you will generally see the scale gradually go down. What is it doing? The air is going into the globe and gas is getting out of it. That extraordinary law of endosmose is displacing the gas, and it is going out. If you shut off a gas meter, when you turn the gas on again you will find that a little air has gone in; the gas and the air have changed places. With these facts before me, I cannot for the life of me understand this 2.7 per cent. I advise those men who are troubled as much about it as I am, not to get down-hearted at losing so much gas. I fancy somehow or other

that with this make of gas of 4.77 feet per pound, it is just possible that the station meter was not just right.

Mr. Walton Clark—I think I misunderstood Mr. Nettleton's statement, for I understood him to say that he goes over his mains once every year, but he says in his paper that he drives his holes 6 or 8 feet apart (which would be 600 or 800 to the mile), and that in the year 1890 the cost of this was $14.57—to drive those holes and to do whatever digging was necessary—per mile of main. Have I misunderstood Mr. Nettleton in that respect?

Mr. C. H. Nettleton—No.

Mr. Walton Clark—Then Mr. Nettleton spends but $14.57 per mile for driving between 600 and 800 holes, which I think is marvelously cheap work.

Mr. W. R. Addicks—I am always deeply interested in the subject of leakage, and I have here some reports of the testing department of the Boston Gas Light Company for the last six months, from January to July, 1891. Our method of testing is by valves. In starting out to work, with 140 miles of main, the question was where to begin. We selected the worst districts and put our meters in them, thus only taking up sections where the leakage seemed to be greatest. The number of tests made from January to July in the test department (which consists of a man and two helpers, and when the one in charge is not at work testing mains, he is oiling valves and keeping them in good condition) was 237, and the amount of pipe tested was 173,882 feet—approximating 32 miles. The leakage on this test was 357 feet per hour. After barring the districts that showed leakage, the meter tests proved the loss to be only 63 feet per hour—making a net gain to the Company of 294 feet per hour for the number of miles tested. We are continuing that policy now. Presuming that the remainder of the system will average about the same as the 32 miles, then, in the 140 miles of the system, the leakage will approximate 20,000,000 feet of gas per year. We have already stopped the escape of 3,520,000 feet per year during the six months from January to July. This does not include leaks reported to the gas office. I have a list of all the leaks reported to the gas office from 1854 to date. I think in 1854 about 154 leaks were stopped during the year—this refers to the main department alone, and not to the service department. Last year some 300 leaks were reported to the gas office, and the total number of leaks stopped amounted to 1,298. Up to October 1st, of this year, we had found 1,863 more. If we keep that record up for the next three months, the same as last year, the number of leaks found in Boston proper will amount to 2,300, making a total for the two years of 3,600 leaks—which are as many as the leaks reported to the gas office and stopped during the years 1876 to 1889, inclusive. Of course we always have from 200 to 400 leaks reported to the gas office, and those, unfortunately, come in the winter months. Comparing the number of leaks, we find that in June, July and August there are from no leaks up to five or six; and of course leaks found in the winter are very much more expensive to find than those which we hunt for in the summer. That is one source of leakage, and I estimate approximately 20,000,000 feet for Boston proper. Now as to the question of meters: Mr. Neal has referred to the fact that the Boston Gas Light Company started out to test every meter on the consumer's premises. We gave that up after two months trial. One of the helpers in going down a trap door in a store, unfortunately, left it open, and it cost the Company $11,000 for that little repair. So from that time on we have not tested any more meters on the premises of the consumers. We now remove the meters by districts. Last year we removed 9,000 meters, without much system about it, except that we went where the consumers' bills were small; but we are now taking them by districts, removing them systematically, leaving those which were put in within a year and a half, and which we know are correct. The State Inspector reports only gas meters fast, slow and correct, and as I felt that in order to answer the question whether it pays to do this work, something more ought to be given, I had a table made up. I have before me one of the monthly tables, which includes not only the fast and the slow, but also indicates the percentages of fast and slow. It is perfectly manifest that a three-light meter non-registering should not have the same value as a hundred-light meter non-registering. In the three months of July, August and September, we removed 873 meters. Of those 549 were correct, 89 were fast, and 235 were slow. Then we took each meter and multiplied it by the number of lights. For instance, if we had 10 ten-light meters, we would multiply the ten lights by the ten meters, which would give us 100 lights, and would be the equivalent of $\frac{1}{100}$ light meter. That gave us some idea of the number of lights fast or slow. In other words, the results were reduced to 1-light meters, 1 per cent. fast or slow. This involved a great deal of work, but not so much as it would to move the meters when it was not necessary to do so. The results were as follows: In July 8,014 1-light meters were 1 per cent. slow over and above those that were fast—that was the difference between the two, there were more slow than fast. The difference between the two was 8,014 1-light meters, 1 per cent. slow; in August there were 6,081; in September, 5,138, making a total of 19,233 1-light meters 1 per cent. slow. That is equivalent in removal to 773 meters, or 3 per cent. of the meters we have in use. On the supposition that all the meters are equally bad and equally good in the various districts, that would be, then, for the whole district, 641,100 1-light meters 1 per cent. slow in Boston proper at the present time. We have altogether in Boston 315,000 1-light meters. That is without any reference to the percentages fast or slow. If a meter was 100 per cent. slow, then that, of course, would be multiplied by 100. That is the reason why the present fast or slow seems so large—641,100. Dividing 315,000 meter lights into the number of feet of gas sold through the consumers' meters, the average amount sold was 3,800 per meter light in Boston per annum. That represents a leakage, considering that the figures hold together, as far as the average fast and slow is concerned, of about 24,000,000 feet per annum leakage through the meters. I do not mean to state that these figures will hold out accurately. I merely say they are hints as to what I believe is going on. Now, as regards the third question—of leakage by condensation. The Roxbury Company, before the works were closed, made their own gas, and their leakage was 8 per cent. They are now purchasing gas through a line of mains approximating 2½ to 3 miles from the source of supply, and their leakage to-day is but 2 per cent.; and you can fairly charge at least a portion of this difference between 8 and 2 per cent. to the apparent leakage on account of condensation. The semi-annual reports by the Roxbury Company in the test department—and the amount tested there is comparatively small—show that in six months the leakage before barring was 126 feet, and after barring it was but 17 feet. There was a net gain of 109 feet per hour. I find that in Dorchester and Roxbury a mile of main will only show a leakage of from 1 to 5 feet per hour. In Boston proper, where there is a great deal of made ground, and a great deal of digging, of course the condition of the main is not so good. Now, as to how to maintain that efficiency. Every test is entered on a ledger which has 8 or 10 lines devoted to one single valve, and the record of that valve is placed on top, at the first test (we endeavor to get a test every year), and the record of each test appears immediately under the previous test. In that way we can see, without going out with the bar at all, whether the condition of that main has deteriorated. That saves all barring, and there is no barring whatever done unless the test department indicates a necessity for it.

Mr. F. H. Shelton—I would like to show how Mr. Nettleton's figures support one or two of the points which have been made with reference to temperature; and I want to show to how small an extent what we term "condensation" amounts in cubic capacity. I do not know in what way the dictionary defines condensation, but to a gas man I think it generally means the quantity of liquor that is deposited in the mains or drips; and that "shrinkage" properly expresses in a gas sense the difference in volume due to temperature and contraction. Mr. Nettleton has drawn our attention to that. He has shown us that on every mile of pipe under his charge there is a leakage of over 68,000 cubic feet per year at present, and that eight or ten years ago the loss per mile per year amounted to nearly 200,000 cubic feet. He gets from his drips on his lines practically nothing. He may get a few gallons occasionally. I will ask you to figure out the small percentage that a few gallons of condensation would amount to on the total amount of gas passed through the main, or even the total amount of leakage. I think that in Mr. Nettleton's case it is so small that we can safely and properly claim that the loss is from shrinkage due to temperature and from leakage, and that there is no practical loss from *condensation* as far as bulk is concerned. I happen to know that in the gas works at Birmingham a partial explanation of the very excellent leakage results is found in the fact that they do not have the heavy traffic that is the accompaniment of large gas works in large cities. They also have few street lamps, which are uncertain leakage factors; but at the same time that only in part lessens the credit of having gotten down to 2.7 per cent. of leakage, which I think certainly entitles one to credit. It is much further than a good many have gotten to on the leakage question. In moving a hearty vote of thanks to Mr. Nettleton for his paper, which has given us much to consider on an interesting question, I think we ought not to forget that one of the chief factors of small leakage at Birmingham, Conn., is Charles H. Nettleton. (Applause.)

Mr. E. McMillin—One point which is of special interest to me is the one discussed by my friend Somerville—the large difference between the leakage at Birmingham and in other places; and I would suggest now

that each man, in his own mind, try to reduce the yield per pound to Mr. Nettleton's standard—or his per cent. of leakage up to yours—and see if you differ a great deal. For instance, I have a works now in my mind that by their station meter show that they make about 5.17 feet per pound, and yet they have an average leakage of 11 per cent. Now you put his yield at 5.17 and his leakage will be about 11 per cent.; and if you put the other man's yield down to 4.77 his leakage will be about 2.7. Now we will all slip along in somewhere between those two points, and we do not differ very much.

Mr. W. H. Pearson—I would like to ask how Mr. Addicks manages to isolate the various districts in the city of Boston, considering there are a number of gas stoves and a great many lights burning during the day time. I would like him to explain how he manages to accomplish that.

Mr. W. R. Addicks—We go around and put them all out. It is very seldom we cannot get the amount of gas used in that way—I know there are cases where we have taken a Sunday test, but as a rule we get the gas shut off. The test department has 2000 valves.

Mr. C. H. Nettleton—Mr. Clark has called attention to the low cost per mile of stopping leaks in 1890—it being $14.57. Of course it is possible there may be an error in the figures, but so far as I know the accounts are kept reasonably accurate. I do a good deal of the work myself, and I try to charge up everything that properly belongs to the leakage account. But would it not be fairer to take the average cost of two or three years, and say that that average was the cost per mile for driving the 600 or 800 holes in question. I think everyone, whose mains are laid in soil such as we have, and who have not tried the method I have suggested, will be surprised at the low cost of driving the holes. It is really very slight indeed. In answer to Mr. Somerville, I can only say that I was surprised and pleased when at the end of the year I found that the leakage showed as small as it did. I had no idea of obtaining any such result; and, in explanation, all I can say is first, that I believe that my meters are correct; and, second, that the pipes are tight, or nearly so. The men go along, not mile after mile, but thousand feet after thousand feet, and do not find a trace of gas. In regard to the yield of 4.77. It is somewhat low; and as I suggested in my paper I think if the yield had been larger the leakage would not have been so small. After all it comes down very much to the question of how much gas can be sold to the pound of coal carbonized; and when a manager can account for 4.60 or 4.70 feet of gas per pound of coal, it makes very little difference whether his leakage is 2 or 10 per cent.

Mr. F. C. Sherman—I would like to ask Mr. Addicks where he found the leaks—around the joints or in the services principally?

Mr. W. R. Addicks—In both. There were very few broken mains, and nearly all the leaks were due to bad cement, or lead joints, or rusting at the services. I cannot give you the proportions found in the test department, but I can give you the proportions of all those that were found. There were 1,073 leaks found and stopped in six months, by the main department, consisting of 172 cement joints, 699 lead joints, 59 broken mains, 97 leaky services, 21 leaky lamp services, 10 leaky columns, 3 leaky gates, 9 pick holes, 2 drip pipes, and of the total number 713 were found by testing. That was the result of six months.

Mr. F. C. Sherman—The Company a few years ago used to confine themselves exclusively to cement joints. Were those cement joints and lead joints some that you put in, or did you find them there?

Mr. W. R. Addicks—They are a mixture. The Company now lays one lead joint to two cement joints. That is its rule. When it comes to good ground, where there is no liability of disturbance, we lay one lead joint to every 100 feet; but the number of broken mains is rather appalling there. I have known as many as two 12 inch mains broken in two days. You will notice that there were 59 breaks in those that I have given you. Of course they all occurred in the winter months. We do not have any broken mains in the summer time.

Mr. F. C. Sherman—I find that outside of New England it is largely the custom to use lead joints. In New England cement joints are almost universally used. I think it is better to have a broken pipe than to have every joint in your circuit leaking.

Mr. W. R. Addicks—I agree with you entirely, and I can cite the old Boston Gas Company in support of that statement. We tested what they laid seven years ago, part of it in fairly good ground and a part in made ground. In the made ground every lead joint leaked, and every cement joint was broken, on account of the settlement, as of course cement joints are not as strong as the cast iron pipe. I must confess that I do not believe in all lead joints, although I did believe in them a few years ago; but in Boston I do not believe in having all lead joints.

Mr. F. C. Sherman—Do you continue the system of gates?

Mr. W. R. Addicks—Yes. In the first place, Boston proper is properly piped, and the additional number of gates is comparatively but a small item to continue; and we find it wonderfully convenient to keep up the system. We have no difficulty in shutting off gas anywhere in the city. I found as many as three gates in succession were rusted, half the way open or all the way open, and were of no value, but since they are looked after they are all in good condition and are kept so.

Mr. F. C. Sherman—That system of gates was adopted after the great fire. Have you had occasion to use those gates in case of fire.

Mr. W. R. Addicks—Yes; on the occasion of the Thanksgiving fire, three years ago, we had to shut all the gates on our 18-inch main and connections. That is the only way we got the fire cut off. We found the mains in front of buildings broken. They were very useful at that point. But I doubt very much, in laying out the Boston system, if they would now recommend spending the enormous amount of money necessary to put in the 2,000 gates.

The President—We have heard a very interesting paper, and have had a valuable discussion of the subject; and I have the pleasure of putting the motion of Mr. Shelton, tendering the thanks of the Association to Mr. Nettleton for his paper. [Adopted.]

(To be continued.)

[Continued from page 623.]

The Steamloop.

[A lecture delivered before the Franklin Institute, by Mr. Walter C. Kerr.]

Efficiency.—This is a feature of the loop on which it would be interesting to develop thermodynamic equations, and compare the same with experimental results, but the investigations on thermodynamic lines involve numerous assumptions on which the doctors will not agree, while experimentally we labor under the disadvantage of having no general case, each experiment requiring to be conducted on a special case, which may have but little bearing on others. By this it is not implied that the quantitative values of loop action are not or will not be determined mathematically and experimentally, but rather to say that such determinations are not of much import or interest in the present discussion. A statement of general features surrounding the efficiency may, however, be interesting. The loop may, like an engine, operate idly, doing no useful work, because there is no water to return, in which case it would be infinitely wasteful, since the efficiency is the ratio of the cost of operations to the work done. The operative cost being practically constant in any given loop, its efficiency must depend wholly upon the amount of water returned and the maximum efficiency will correspond to the largest quantity that it is capable of handling. This limit, however, would seldom be reached in practice, for if constantly doing its maximum work the loop would be in danger of flooding each moment. Practically, therefore, the wide margin allowed for safety and handling unusual quantities of water compels the loop to usually operate far below its maximum capacity rendering it to that extent less efficient. This feature, however, indicates the inadvisability of making loops unnecessarily large. Since the loop puts water into the boiler against resistance, energy must be expended. This energy represents heat lost, and this loss is the cost of operating the loop. No exact determinations have been made of this loss, but it is obviously very small. This is indicated by the fact that the loop will work even when covered with non-conductor. That the energy required is very small may be deduced as follows:

A 100 horse power engine using 30 pounds of water per hourly horse power requires 3,000 pounds per hour. If 10 per cent., or 300 pounds, be returned to boiler per hour, and difference of pressure between separator and boiler is 10 pounds, then about $\frac{1}{2\frac{1}{5}}$ of 1-horse power is required to do the work.

In the above it will be noted that we have assumed a very large amount of water to be returned, and have assumed a large difference of pressure against which to return it. Consequently the above figures are more than generous, and it is doubtful whether half this amount of power, or say $\frac{1}{5\frac{1}{3}}$ of 1-horse power, is used in the average case. As the loop is required to exert so small a power, it is evident that its efficiency, as measured by our ordinary ideas of economy, might be extremely poor, and yet its efficiency for the purpose for which it is used very high; that is, while its absolute efficiency considered as a pump with which to get water into a boiler might be low, the small amount of energy needed to perform so valuable a service as continuous return, may make it relatively an article of high efficiency.

Another way of looking at this is as follows: A 1-inch pipe may be

presumed to lose by radiation .1 of the heat which would be lost from a 10-inch pipe. Now, suppose a 10-inch pipe is running from a boiler to an engine, and the loss by condensation is being wasted through a drip, to say nothing of the steam also lost. Now, the loop will add $\frac{1}{10}$ to the condensation, but to compensate for this it returns to the boiler the original $\frac{1}{10}$ condensation in the pipe, plus the $\frac{1}{10}$ condensation in itself, at a temperature (say) of 250° to 300°, which is evidently desirable as compared with wasting the condensation of the 10-inch pipe.

An important factor in its practical efficiency is the improbability of leakage existing, while other methods involve great opportunities in this direction.

There are other interesting developments with relation to efficiency which cannot be explicitly stated because of insufficient experiment. They may be indicated as follows: In any system which involves carrying from the boiler steam at a given temperature and returning a part of same to said boiler, there must be some loss of heat. The amount will depend on the differences of temperature to which the steam or resulting water is subjected and the time. All systems contemplating the collection of water in volume, handling it through pipes in volume and pumping it back in volume, contemplate or involve the use of apparatus having itself a temperature widely different from that of live steam from said boiler. They also contemplate the moving of a solid body of water which can only be done at a very low rate of speed. Hence, any return made on such system is essentially a wasteful one. The steamloop makes a return through apparatus which is small in mass and kept at a comparatively high temperature, while the current through it is extremely rapid, bearing in this respect no relation to any other device. Both difference of temperature and time are so reduced as to give evidence of superior efficiency. In fact, it may be said that the steamloop cannot be reasonably compared with any other form of return that has yet been made, as it stands alone in its principle and utility.

This whole question of efficiency is, however, one of curiosity rather than importance, for, as previously stated, the whole matter is relative. The mechanical features of the loop system in removing the objectional water from pipes, through a continuous closed circuit back to boiler, takes precedence over any questions of efficiency, especially considering the very small quantities of power and their heat equivalents involved. Just as an edge several inches wide may be sharp for the bow of a steamship, and an edge .01 of an inch dull for a razor, so may the expenditure of a few thousand heat units in a lightly loaded steamloop be economical for a loop when the same number of hundreds of units would be uneconomical for a compound condensing engine furnishing the same foot-pounds of work. Loops, therefore, are simply to be compared with each other, and in this field there is still ample room for further accumulation of data.

In practice, the data obtained from large numbers of loops in operation vary so widely on account of various conditions imposed that it is probably impossible to obtain reliable information from which deductions can be made, except on special apparatus erected on a large scale for experimental purposes only. The useful work done by the loop cannot be measured solely by the amount of water returned to the boiler, for if this water is all condensation and primage, its removal produces less economic effect on an engine than if it were held in suspension in the steam. Thus it may be that the exertion of a small fraction of a horse power by a loop may cause the steam which it dries to exert many times more power in its expansion in the engine cylinder. The loop to do this might be lightly loaded, so that its own efficiency becomes relatively poor, while near by there might be a loop, heavily charged with water or primage and condensation, whose efficiency is relatively high, yet whose economic effect upon an engine is of less value. Therefore, the thermodynamic efficiency of a given loop is not proportional to its value to the user, even though we make no account of its value as an assurance against accident by water.

Results.—The result of steamloop action may be briefly summed up as follows:

1. Saving the water of condensation, entrainment and primage.
2. Saving the heat contained in said water.
3. Saving the steam systems from water, thereby reducing liability to accident.
4. Returning pure water to the boiler.
5. Preserving uniform temperatures, thus obviating difficulties due to expansion and contraction.
6. Prevention of direct loss which usually exists from open drains, drips, tanks, etc.
7. Enabling engines to start promptly.
8. Maintaining higher pressures at the end of long lines.
9. Maintaining higher temperatures in jackets, dryers, etc.
10. Increasing the efficiency when steam is used expansively.

All of the above are more or less evident from what has preceded, except the latter, and on this there is some honest difference of opinion. The earlier writers on thermodynamics make little mention of the effect of entrained moisture on the expansive properties of steam, but by common consent rather than any demonstration, they seem to agree that moisture produces an ill effect simply to the percentage amount of its presence. That is, 5 per cent. moisture will increase the water rate of an engine only 5 per cent. Experimental data on this point seem very meagre, the only recent work being that of Prof. James E. Denton, of Stevens Institute, on a comparatively small engine, in which the result indicated was substantially as above. Prof. Denton, however, considers further experiment necessary to establish a conclusion. The opinion of other authorities on this question, including Dr. R. H. Thurston, of Cornell University, and Geo. H. Barrus, M. E., of Boston, agree that the presence of moisture in steam should, and doubtless does, cause an injurious effect in excess of its own percentage. Indications of this are observed in superheated steam where a given amount of heat expended in superheating produces more saving in the quantity used by the engine than the equivalent in added heat, and the same condition should extend to supersaturated steam. Definite knowledge of this is, however, yet to be obtained, but it seems to be the general concensus of opinion that moisture is detrimental to an extent about double its percentage; that is, 5 per cent. moisture in steam, effects the efficiency of an engine about 10 per cent. Further development and opportunity for experiment with the steamloop system will aid in determining this.

Other Applications—Throughout this discourse the description has been confined almost wholly to the application of the loop to the one case where moisture is to be removed before steam passes to an engine or pump. It is thought best to keep this one case clearly in mind, for the loop thoroughly understood on this basis may be easily conceived to servs similar purpose in any other connection. Where live steam is used for drying purposes, the loop may be attached directly to the return, this maintaining a powerful circulation through the heating coils and ridding the system from the condensation which is the natural product of the heating or drying process. In this service, however, the loop has opened up a new feature, that of drving the steam before it enters such heaters, and it is found to yield very beneficial results, by keeping up temperatures and pressures (see Fig. 9). Similarly, steam kettles,

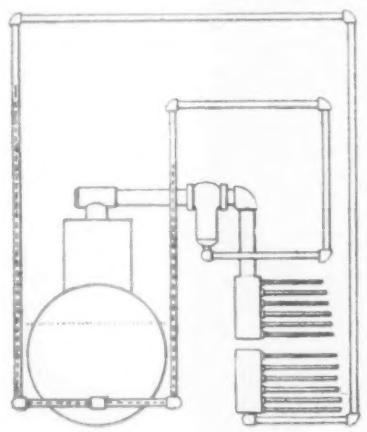

FIG. 9.

jackets of steam-jacketed cylinders, and even steam heating apparatus can be handled with ease and efficiency. Much apparatus of this nature, however, is throttled down to a degree that seriously interferes with loop application, and in ordinary steam heating the opportunity is exceptionally good for large air leakage, which would be deleterious. It is, therefore, not easy to concisely state to just what purposes the loop may be practically applied, but it is safe to say that it is desirable on any live steam pipe or any high pressure or unthrottled dryer heater or jacket.

The development of the loop system has not stopped with the simple applications here recorded, but has been carried into fields of wider application. Perhaps no device has appeared during late years on which more thought and careful consideration has been bestowed. Its possibilities have been explored and its limitations studied to such an extent that the whole evening would scarcely suffice to enumerate features of interest that have not been included in this lecture.

Thus, the steamloop becomes a device of much broader proportions

than appears from first inspection of its operation or the rudimentary understanding of its principles. It may seem strange that its application has not before been developed, but that is doubtless due to want of clear comprehension of its somewhat peculiar functions and their utility, for those who are connected with steam engineering must in many ways and under various circumstances have had opportunity to observe the phenomena which concern its action. We are, therefore, entitled to respect quite highly this useful combination, whose worth can never be accurately estimated, since its chief service is to prevent certain losses and accidents of variable character, and whose extent is the only measure of the loop's value.

The Multiple Current.

A writer in *Industries* remarks that there are really two types of multiple current motors; in one the field magnet is separately excited, in the other it is excited by the armature.

In the first, or separately excited kind, the action is practically the same as in an ordinary single current machine, except that there is some tendency to start. The efficiency is the same whether the machine is wound for a double or a triple current. The only point to be noticed in comparing the double and single current machines is that the output of a single current dynamo or motor is somewhat less because the armature is not fully utilized, some of its available surface not being occupied with wire. We find ourselves in opposition to no less an authority than Herr Dolivo Dobrowolsky as to the relative output of a triple current machine when coupled with three independent circuits, that is to say with six leads, and when coupled to three leads. If the electromotive forces in the armature circuits vary harmonically, we find the output with a given number of armature turns, and the same size of copper, and the same current density, whether coupled up to three separate circuits or to three leads, will be the same. We will leave the reader to form his own opinion; but, according to our view, the efficiency of the triple current machine is high whether used as a generator or motor.

Passing to the motor of the Tesla short circuited type, we have a machine whose field is excited by armature reaction. It was pointed out some three years ago by the present writer that to make a Tesla motor efficient the armature wire must be large enough to carry the large number of ampere turns necessary for exciting the field magnet, and that the best way of meeting the difficulty was to make the armature large and to keep the air space small so that few armature ampere turns are necessary to excite the field. It was suggested that the machine should therefore be made with an armature of the Pacinotti type. The Allgemeine Electricitats Gesellschaft have come to the same conclusion apparently, but have gone further, adopting the embedded winding, which has the advantage of Pacinotti's teeth without the drawback of producing useless Foucault currents that merely cause waste of power. If the loss by the resistance of the copper of the armature is kept down, there is no reason whatever to suppose that a Tesla or Dobrowolsky motor is not just as efficient as any other type.

It is urged that the triple current gives a more uniform field than the double, and that the triple current as used in Germany is, therefore, more efficient than the double as used in America. As the loss of efficiency due to the variation of the field throughout the period caused by a single current is not appreciable in the ordinary alternate machine, even when the armature reaction is considerable, it is hardly likely that there can be any loss to speak of with a double current. Moreover, the closed field circuit is itself of such low resistance that it takes currents which practically prevent any variation of the field. A Tesla motor with a double current may thus be made just as efficient as with a triple current. It is moreover possible to design the closed coils and magnet poles so that the variation of field produces no waste of power by Foucault currents; in fact, a machine could be made with no current in the closed coils at no load. We do not, therefore, think that there is any great need for the determination of the efficiency of such motors; the chief fault lies not in the real, but in the apparent waste of power. The magnetic circuit is excited by an alternate current, or rather by three alternate currents. The result of this is that the current taken by the motors is enormous, even when small air space machines are used.

The great want at present is an alternate motor for comparatively small powers, such, for instance, as 2-horse power for use in connection with supply stations. In order to use the triple current a 3-lead system of conductors must be used. This is a very serious drawback, and the difficulty of measuring currents and powers in the circuits is a great evil. If six leads are used there are, of course, three independent circuits, and instruments can be inserted in each in the ordinary way; but if the three circuits are run with only three leads the measurement becomes troublesome, and, as far as we know, impossible. To get over this difficulty Herr Dobrowolsky prefers six leads. It is possible, however, to bring six leads from the dynamo, and to insert measuring instruments in the three independent circuits. The leads may then be combined into three, and led round a town, for instance, at 2,000 volts. At any house a triple transformer may then be arranged with three primary circuits and six secondary. The secondary circuits can then be measured as three independent circuits again. One triple or three ordinary transformers can be used, as desired. Closed circuit triple current transformers will be a little more efficient than three single current closed iron circuit transformers for the same total output. We are here again at variance with Herr Dobrowolsky, but the same arguments apply to the transformers as to the dynamo. This gives the same efficiency, as far as the copper is concerned. By combining three closed circuits into one triple current transformer the weight of iron can be reduced a little, so a slightly higher efficiency is obtainable.

Schuckert & Co. exhibit a triple current transformer. They also show some very interesting machines. Imagine a direct current Gramme armature in a two pole machine. The armature turns may be connected up to a commutator for giving direct currents in the usual way. Connections may also be made from two opposite sections to two contact rings, and a single alternate current can be obtained. If three contacts are made at equal intervals, a triple current can be collected from three contact rings; and if four connections are made at equal distances, two double currents can be collected from four contact rings. Messrs. Schuckert make a machine with a direct current commutator, and several alternate current contact rings, all supplied by one armature. The result is extraordinary. The machine can be worked as a direct current dynamo, exciting itself, and giving external current. It can also be arranged to give a single, double or triple alternate current at the same time, if the necessary contact rings are supplied. In fact, such a machine can give as a dynamo, or take as a motor, direct currents, and single, double or any multiple alternate currents; it can act as a dynamotor, converting any of these into any other, and all this is done with one armature circuit. These machines have eight poles, so they cannot be made to give high efficiencies, but, of course, the same type of dynamo can be made with more poles.

We have given so much space to the discussion of the multiple current, because so much has been said about it, and so much is expected from it. We have reluctantly come to the conclusion that it has no great future before it, and that it is not really the solution of the problem; and as this opinion seems to be opposed to that of nearly the whole electrical engineering world, we felt obliged to give reasons to support it. The subject may be summed up from our point of view as follows: For transmission of large powers from one dynamo to one motor, or from several dynamos in parallel to several motors also coupled in parallel, the multiple current has some advantage in starting. This is small, because there is no difficulty in starting a large motor by means of cells, or by starting the dynamo and motor together. The multiple current also has the advantage that a given machine will give a somewhat larger output because the whole of the available armature space is utilized. These small advantages are much more than counterbalanced by the extra cost of insulating and installing three wires, even though the weight of copper is the same in all cases. In addition to this, a single alternate current transmission may supply large motors, and may also feed lamps, etc., at the other end, without a complicated three wire system. We therefore think that the multiple current has no advantages for use in connection with large motors.

We now turn to the case of small motors on supply circuits; and we assume that they cannot be made for the single currents. In order to let a supply company run motors, it has to put down a special system of triple leads, involving all sorts of complication, and puzzling consumers, who hardly understand the ways even of a single alternating current. The motors may be easily constructed, and they may work very efficiently, but the large currents taken by them will give trouble if a high-pressure system with transformers in the houses is used. For instance, if a 2-horse power motor takes 100 volts and 70 amperes, it will need a 10-horse power transformer to supply it. In addition to this it will need a special meter. Of course condensers might be used to supply the exciting currents, but 100-volt condensers are expensive to make, and this adds to the cost. There is no difficulty in supplying exciting currents by condensers at the station, but in the case of motors this demands the large transformers just mentioned. If the town is supplied by large transformers, the exciting currents do not give much trouble, as, unless a very large number of motors are used, the trans-

formers need not cost much more. In the case of supply stations working lights, the multiple current allows us to use motors too, but the price is a complicated system of wires and transformers throughout the whole area. The probable demand for small motors is far too trifling for it to be worth while to alter a system merely to be able to supply it. It would be much cheaper to run a third circuit and use a direct current for motors and for electro-plating requirements.

We also fail to see that the triple current is any real advance beyond the double current machine, to whose development Mr. Tesla has devoted so much energy. Mr. Tesla, in America, and Messrs. Hutin and Leblanc, in France, are making progress in the direction of splitting a single into a double current by means of self-induction, capacity and resistance suitably arranged. The solution of the problem of small motors may lie in this direction, but we do not think it lies in multiple current motors, which do not fit the present systems of lighting.

In mines, especially in dangerous mines, where it is most important that there should be no sparks, and where simplicity is demanded, the multiple current will probably come into general use; but at present it does not even promise a solution of the problem of alternating motors on supply circuits. What is asked for is a small motor to suit existing alternating circuits; what is offered is a motor which demands a new and complicated system of supply to operate it.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

WORD comes to us of important changes in the management of the Cadiz (Ohio) Gas Light Company, caused by the resignation of Secretary and Superintendent, Mr. A. N. Hammond, who retired from the Company, that he served so ably, on the 1st inst. Mr. I. C. Moore has been chosen General Manager, Secretary and Treasurer by the shareholders, and Mr. Wm. Lee, who acted as foreman of the works for several years past, has been named as Superintendent of the manufacturing and distributing plants. The Secretary and Treasurer's office will, as before, be at the First National Bank of Cadiz.

EVERY gas man in Ohio is conversant with the fact that the Cadiz Company is greatly indebted to Mr. Hammond's sustained effort for the prosperity that it enjoys, and he leaves it in good shape for his successor, whose reputation as a business man is excellent. We are also more than pleased to note the spirit of fair play that prompted the elevation of Mr. Lee to the Superintendency.

IN the meantime we may note that Mr. Hammond will retain an indirect connection with the gas industry, as he goes to Chicago to engage in the manufacture of artificial ice; so that instead of being a producer of gas residuals he will be a consumer of them. He always was a champion of cheap gas—in fact, if we mistake not, illuminating gas for fuel is sold in Cadiz at $1 per 1,000; hence in his new position he may still be enabled to help along the good cause. He has the good wishes of everyone in the profession for success in his present venture.

IN our last issue brief mention was made of the novel manner in which the Cincinnati Company celebrated the completion of its new gasholder, and to that mention we add the following particulars forwarded us by one who participated in the "ceremonies":

"Quite the most novel lunch of the year was served a few days ago, in Cincinnati, the guests being entertained in the Cincinnati Gas Light and Coke Company's new holder, which is located at the corner of Second and Rose streets. The interior of this monster iron structure was not quite the most inviting place for a friend to take another friend for lunch, but a most enticing meal was served there by the Kepplers, with a musical accompaniment, etc. The hours that the invitation proclaimed for this strange event were from two to four, and in that time almost all the local stockholders of the Company, and many of the city officials partook of the hospitality of the genial President, General Hickenlooper, and his staff of worthy assistants. A temporary stairway in Rose street, just below Second, enabled the visitors to enter the iron monster, and once within the extensive edifice, people were startled by the sight. Eatables and drinkables were in abundance, and were enjoyed. This holder is the tenth that has been built by the Company in its almost half century of existence, the first having been constructed in 1842. The latter held 50,000 cubic feet, and its tank, although covered with buildings, is still in use as a tar well. From 1842 on, the constantly increasing demand for gas necessitated the construction of other and larger holders, until the Company, last year, found that while it had an aggregate storage capacity of 3,825,000 cubic feet, it was not sufficient for the volume of gas necessary to meet the constantly increasing consumption. The Directors therefore wisely ordered the erection of this holder, and its construction was carried out under the personal direction of Mr. N. G. Keenan, and the immediate supervision of Mr. Wm. A. Miller, Superintendent of Manufacture, assisted by Mr. Frank Foster, Superintendent of the West End station. The tank excavation was begun February 23d, and, though interrupted, was completed May 15, during which period 10,809 cubic yards of earth were removed. The concreting laid as foundation and covering of the cone required the use of 1,600 bbls. cement and 950 perches of broken stone and gravel. The J. M. Blair Company built the tank—157 feet in diameter and 31 feet deep—using in such construction, 935,000 bricks, 1,800 bbls. of cement and 600 yards of sand. The retaining wall, containing 730 perch of stone, was built by John Sperry. The holder was built by the Stacey Manufacturing Company, of Cincinnati, and is in 3 sections, each 30 feet in depth. The inner lift is 150 feet 6 inches, middle lift, 152 feet 9 inches, outer lift, 155 feet, and is one of the largest holders in the West. Its working capacity is 1,584,273 cubic feet. Quite a feature of the luncheon was the presence thereat of Mr. R. B. Field, who was among the first consumers of the Cincinnati Gas Company. Between 300 and 400 guests were entertained, an not a hitch marred the proceedings."

THE proprietors of the Washington (D. C.) Gas Light Company have applied for permits to put mains in the following streets: 18th street, west side, between D and E streets, northwest; Rock Creek Church road, from Whitney avenue toward Spring road; Sampson street, between 17th and 18th streets, northwest; Florida avenue, west side, between Rand and S streets, northwest.

THE Portsmouth (N. H.) Gas and Electric Light Company has formed a fire company for the better protection of its property. The "boys" are very prompt in the matter of attending to the "drilling" calls.

THE Railway Lighting and Heating Company, for the purpose of lighting and heating railway cars, has been incorporated at Chicago by Messrs. F. C. Rutan, L. Spahn and John G. Campbell. It is capitalized in $500,000.

THE West Newton (Pa.) Electric Light and Power Company has purchased the franchises and property of the West Newton Gas Company, and will hereafter operate the same as one enterprise. It is to be hoped that the combined Company will be a more profitable venture than either was when in separate existence. The gas plant was of the Smith & Goldthorp type, and was badly run down, and the price at which gas was sold would average $3.80 per 1,000. The new owners are now remodelling it.

THE Gettysbury (Pa.) Gas Company and the city authorities are consulting over the policy of lighting the town by a mixed system of gas and electric incandescent lamps.

THE following particulars respecting the growth of the gas business at Sioux Falls, South Dakota, are taken from a recent issue of the Sioux Falls *Daily Press*: "The extensive improvements made by the Sioux Falls Gas Light Company during the past year have been going on by degrees, as it was possible to make them without interruption to the business, and very few are aware to-day of the extent of what has been done. It built new generator, boiler, engine and storerooms, a workshop and wagon sheds, a purifying house, a coal storage house, a gasholder of 100,000 cubic feet capacity, and new offices. In addition to this, a new 12-inch leading main was put through Phillips avenue. A reporter of the *Press* who called on Superintendent L. D. Spragle recently, gleaned the following from a chat with that wideawake gentleman: 'The Company, he said, has faith in the growth of Sioux Falls. We have spent about $65,000 in tearing down the old plant, rebuilding it and fitting it up with the latest improved systems of gas making. There is not left standing of the old works a single brick, and we have a complete new works from beginning to end. Our capacity is now in excess of our demands, but if our sales continue to increase at the present rate, it will not be long before our capacity will be tested to the utmost.'" Here follows a description of the plant, which was constructed by the United Gas Improvement Company, of Philadelphia, which is evidently very complete. Following which description Mr. Spragle, in response to the reporter's suggestion that gas was being largely used for fuel at Sioux Falls, said: "Yes; gas is coming very largely into use as fuel. Our success in the sale of fuel gas and gas stoves has exceeded our most sanguine expectations. In April of this year, we had but 40 stoves in use, but by that period in 1892, we will have 125. This part of our business is going to be of great importance.

We have received only words of praise in every instance for the working and cleanliness of our gas stoves. We believe it possible to gain every householder on our system of mains as a consumer of gas for fuel, and we shall not rest satisfied until this is accomplished. A gas stove is essentially a poor man's stove. Families in small houses of three or four rooms each can do all their work for as little money as other fuel would cost, and at the same time avoid the inconvenience and discomfort arising from the use of the cumbersome, wasteful coal heated range. So little heat is wasted in the use of gas stoves that their operation permits the cook to live in coolness in the kitchen. Gas stoves are also admitted by the owners of flat houses to be the most available means of cooking in such dwellings, and the residents agree therein, since there is in their use no unpleasant odor, no smoke, no smudge, as compared with the gasoline stove—to say nothing of the difference in respect to the item of one's personal safety, as between the gas and the gasoline cooker. We have now on hand some very beautiful stoves for heating rooms, but in regard to continuous heating by them we have not said much as yet. For intermittent demands or needs, however, such as the heating of bath rooms, bed rooms and the like, they cannot be excelled either in point of economy or convenience. So also is it with the use of gas for power purposes—all the printing offices in our city employ gas engines. As a lighting agent we claim to, and actually do, give more light for the same money than can be obtained by or from any other means. The lights being capable of manipulation, entirely under the control of the user, they may be used at any rate of consumption consistent to the needs of the user." The *Press* man, in concluding his account of the interview with Mr. Spragle, says: "The gas works and their belongings are kept up in a commendable manner, and would not be offensive were they located in any part of the city. The manner in which the Company has gone about the rebuilding of its plant certainly shows the appreciation of its owners and their expectation as well, that the growth of the city is to be in keeping with its past strides."

At the annual meeting of the Consumers Gas Company, of Toronto, Canada, the following Directors were chosen: Samuel Alcorn, James Austin, M. Baldwin, G. S. C. Bethune, Henry Cawthra, George R. R. Cockburn, M.P., Isaac C. Gilmor, George Gooderham, James Scott, Larratt W. Smith, Q.C., Thomas R. Wood and the Honorable Frank Smith. The Directors subsequently perfected the following organization: President, Mr. James Austin; Vice-President, Mr. Larratt W. Smith, Q.C.; Secretary and General Manager, Mr. W. H. Pearson.

It is understood that, if such course has not already been determined on, the price of gas in the Carondelet district of St. Louis is to be reduced to $1.18 per 1,000 cubic feet. The Carondelet Company's district is bounded as follows: South side of Meramec street to the River des Peres and thence to Grand avenue.

The fraternity will be pleased to hear of the continued improvement in the health of Mr. W. W. Goodwin, who bears his ills with the equanimity which characterized his most virile days.

At about 9:15 A. M. of Sunday, the first inst., Patrick Scully, a foreman rigger, in the employ of Messrs. R. D. Wood & Co., was engaged to take down a derrick, used by his firm in the erection of a 2,000,000 cubic foot capacity gasholder, for the Standard Gas Light Company, at its distributing station at 131st street, near 12th avenue, this city. In taking it down, certain guy ropes were required, and one of these, supposed to have been fastened by Scully himself, was found not to have been so adjusted when the most critical part of the operation was arrived at. When asked about it, prior to the time at which the guy would come into operation, Scully replied that it was all right; but when the strain of the heavy beam of the derrick came upon the rope, the latter slipped and the beam fell, carrying others with it. By its fall Scully was instantly killed, and a man named William Henry was seriously wounded. It was one of those accidents which will occur on works under the very eyes and under the very direction of an experienced workman, for according to our information the poor fellow who lost his life was altogether to blame.

The Rahway (N. J.) Gas Light Company is again performing the public lighting of that city, the new contract having gone into effect on the first inst.

The following account of the gas and electric plants of the Charlestown (Mass.) Gas Company is taken from a recent issue of the Charlestown *Enterprise*: "Less than 40 years ago the Charlestown Gas Company began to supply the citizens of this district with artificial illumination. The charter of the corporation was granted in 1848, but it was six years later that actual operations were begun. Since then the demand upon the Company's resources has kept steady pace with the increase in population of Somerville and Charlestown; and the adoption of electricity as a means of lighting streets and buildings was promptly followed by preparations to enter a new and practically experimental field. The record of the Charlestown Gas Company has been one of conservatism allied to progress. No step has been taken without a careful consideration of its importance, and no movement has been made that has not justified the wisdom of making it. The original capital has increased from $50,000 to $500,000, but the value of the plant, the magnitude of resources, and the perfection of details have increased in a still greater ratio. The works of the Charlestown Gas Company are located at the Neck and on a portion of the Peninsula that is rarely visited by the average citizen except on matters of necessary business. And yet a visit to these works will repay anyone for the trouble, for there is much to learn, much to admire, and much to reflect upon in the modern methods of evolving gas and electric light, as exemplified in the most scientific manner by the local Company. To the average visitor, as to a representative of the *Enterprise* who recently inspected the works, the electric light plant is the greatest attraction. On September 16, 1886, the Charlestown Gas Company began to furnish arc lights. Since that time the work has proceeded steadily and continuously; there have been no interruptions or breakdowns, and not an accident has occurred. Such a record is almost unparalleled in the history of the electric light industry, and speaks volumes for the manner in which the Company's operations are carried on. The boiler house is unsurpassed by any other of its size in the country. It is 60 by 45 feet, and contains five boilers, each of 125 horse power. They were made by the Cunningham Iron Works Co., of this district, and have all the latest improvements. The fittings are of brass. The smoke escapes through a stack 100 feet high, 12 feet in diameter at the base, tapering to 9 feet at the top, with a flue 6 feet in diameter from top to bottom. An iron flue at the top of the boiler has a diameter of 5 feet, and effectually disposes of the smoke from that source. The first installation of electric light machinery was in the condenser room of the gas works, and consisted of a 60 horse power engine, with two 30-light dynamos. These were afterwards transferred to the original power house, which was 50 feet long and 40 feet wide. Additions were subsequently made, until now the length of the building is 100 feet, or twice the original figures. It contains 10 Brush dynamos, operated by five Armington & Sims engines of 60 horse power each, and one Thomson-Houston dynamo for incandescent lighting, run by an Armington & Sims engine of 135 horse power. The incandescent plant is new, and with it 650 incandescent lights can be furnished. The Brush machines supply the arc light current and also incandescent lights from the arc current by individual distributors and in series. There are now about 200 arc lights and some 350 incandescents supplied by the Company, and the number of both is steadily increasing. The power house presents a striking spectacle when the evening's work has begun, and Electrician William J. Gavin, who has been in the Company's service since the plant was constructed, is engaged with his assistants in regulating and guiding the powerful products of man's inventive genius. Superintendent Patrick Coyle, under whose direction the electric lighting department is so successfully conducted, states that the demand for service is still unabated, and that already plans are being made for further enlargements and for a substitution of 135-horse power engines for those of 60-horse power now in use. Enough has been said to show that the electric light plant of the Charlestown Gas Company is equal to the best, and its service, as may be seen by thousands of people, is unsurpassed. But, says the critic, while the Gas Company is thus keeping step to the lively music of electric lighting, what has become of the field which it once exclusively cultivated? Is it it getting ready to abandon it? Ask those who live within a stone's throw of the works if the indications point to a diminution in the quantity of gas made and consumed. Ask Messrs. R. D. Wood & Co., of Philadelphia, Pa., who have a contract for building a new gasholder, with a capacity of 250,000 feet, and who are already erecting it. The tank, which is to be of steel, will be a novelty in this part of the country. It will be 88 feet in diameter, and the plates at the bottom will be three-quarters of an inch in thickness. It will be 23 feet in height. The holder will be of the double lift order, supported by 10 iron columns. The whole work is to be finished by the middle of December. Already the Company has a holder of 200,000 feet, with an auxiliary one of 75,000 feet, on Chauncey place. The demand for gas keeps pace with the call for electric lights, and especially in Somerville, where building operations are brisk. The Company is not restricted in its Somerville field, but there is an unwritten agreement by which it supplies all

of the section on its side of the Boston and Lowell Railway's tracks. The Cambridge Gas Company takes care of the rest. It is impossible in the narrow limits of a newspaper article, to do full justice to the magnitude of an industry of this importance. But it is possible to present the salient facts, shorn of technical details and prepared for the casual reader; and it is not only possible but necessary that due credit should be given to the men who have made this local industry the success that it has proved to be. The executive head of the Company, President Jas. F. Hunnewell, is one whose reputation as a gentleman of letters and a historian of exceptional accuracy has not been attained by a sacrifice of his interest in this purely local and commercial enterprise. He has ever since his connection with the Company shown a commendable spirit of progressiveness in conducting its affairs, and has not been slow to appreciate the necessity for liberal methods in dealing with the public. For years George B. Neal has been Treasurer and Manager of the Company, and the fruits of his wisdom are as enduring as they are useful. He has been fortunate in his lieutenants—Patrick Coyle, Superintendent of the Company, and Richard Coyle, Superintendent of the works. Both are tried and true men, and each has labored loyally in the Company's interest for many years."

THE Asheville (N. C.) Light and Power Company announces that its gas making troubles are at an end, and its consumers can rest assured that their supply will not be interrupted in the future—the near future at any rate.

THE handsome office structure of the Nashville (Tenn.) Gas Company was badly damaged by fire, on the morning of October 30 The press reports says that the loss amounted to $35,000.

MR. M. S. HART, who since July, 1881, has acted as Secretary and Superintendent of the Las Vegas Gas and Coke Company, of East Las Vegas, N. M., writing under date of October 29, says: "I desire to state that I have tendered my resignation as Secretary and Superintendent of this Company, the same to take effect November 1st. The Company stopped the manufacture of gas and is devoting its time to furnishing electric light to its patrons. However, I believe it is only a question of time until the citizens will want gas (the old reliable) again."

MR. HART is engaged in the business of plumbing and steamfitting in Las Vegas, and in the sale of all supplies, fittings, etc., connected therewith.

THE authorities of Duluth, Minn., have been considering the advisability of purchasing the plants for the supply of gas and water to the city, now operated by the Duluth Gas and Water Company, in order that the same might be carried on for public account. To secure an estimate of the value of these plants, the authorities retained Mr. Chester B. Davis, C.E., of Peoria, Ills., and that gentleman completed his investigation towards the close of last month. He reports that the total value of the same to the city would be not less than $2,000,000—at the present time; and adds that if the ratio of growth of the city be maintained that value would be increased to $2,500,000 in the space of five years. He estimates the gas plant and franchises to be worth $650,000, and in recounting the plant details in this division of the Company's property, he says: "The generating and storage works consist of a complete plant on the Meeze system, having generating capacity rated at 280,000 cubic feet, and in addition, two Flannery generators, each of a rated capacity of about 120,000 cubic feet, making a total of 520,000 cubic feet per 24 hours. The holder has a capacity of about 200,000 cubic feet. The arrangement and condition of the works are good. In the distributing system the mains vary from 2 to 16 inches in diameter. They are mostly of cast iron, and there are in all 149,639 feet, or practically 28½ miles. The cast iron averages heavier and stronger than that generally used in gas works. There are about 140 gas post services in, and about 40 posts standing. At slight expense all these could be placed in condition for effective use."

[Since this was written we were informed that the City Council has accepted the offer of the Company to sell its plant to the city for $1,950,000, and that a special election will be held on the 19th inst., for the purpose of approving or negativing the Council's determination.]

Pressure in Gas Retorts.

The *Gas World* says that at the last meeting of the Bavarian Gas Association, Dr. E. Schilling read a paper on the above subject, in which, after remarking that the most various mishaps—plugging of the ascending main, thickening of tar, excess of graphite, small output, bad gas—all are, from time to time, attributed to "pressure in the retort," he went on to say that this pressure is an exceedingly important circumstance; a low pressure enables gas to come off freely, and facilitates the passing over of hydrocarbons of moderate volatility, so that the tar is thereby rendered more valuable. The low pressure also facilitates dissociation of the components of the coal.

When water is being boiled, a rise of 20° in the boiling point is the consequence of doubling the pressure; to lower the boiling point by 20° one must lower the pressure from 76 to 40½ cm. of mercury. What are the pressures in the retort? They have been very seldom measured. On investigation, it is found that the pressure-curve fluctuates above and below a line of pressures, and itself presents numerous minute serrations. The fluctuations never exceed a few centimetres of water, and appear to be mainly due to the want of perfectly uniform action in the exhaust; and such variations of pressure are in any case probably too small to affect the chemical processes going on in the retort.

The state of affairs is somewhat different when there is an obstruction in front of the retort, so that the gas produced is not immediately withdrawn, and a high pressure is developed. Then there is a greater production of graphite, and the permeability of the retort walls plays an important part. If too small a pressure may possibly draw air in through the retort walls, too great a pressure will drive gas through them. What is the permeability of retort walls? In order to investigate this, the writer closed the end of an ascending main of a retort at work but not charged. Gas was led, under pressure, by a lateral pipe, into the ascending main and the empty retort. The amount of gas so led in was measured by a meter. This enabled the escape of gas which took place when any given pressure was maintained in the retort to be measured. Everything was so arranged that there could be no escape of gas except through the retort walls. The retort had been at work for 4½ months, and was thickly lined with graphite. It was first tested as it stood (I.); then cleaned out and its fine cracks filled up (II.); then charged and examined empty after 24 hours (III.); then similarly examined after 48 hours (IV.). Assuming that each retort produced 353 cubic feet per hour, the percentages of loss were, under the various conditions stated above, and under various pressures, the following:—

Pressures in the Retort.	I.	II.	III.	IV.
0	none	8.0	0.4	0.4
0.4 inch	0.3	—	2.5	1.4
0.8 "	—	—	2.6	2.4
1.2 "	0.4	—	4.0	3.6
1.6 "	—	36.0	6.1	4.3
2.0 "	1.1		—	—
2.4 "	—	Not measurable	—	—
2.8 "	—		9.0	8.3
3.2 "	1.8		11.0	9.0

When the pressure is low, and the retort well lined with graphite, the loss is very small; at 2 inches pressure it is just over 1 per cent.; and above that pressure the loss increases rapidly. Freshly cleaned out retorts lose gas indefinitely, but come right to an appreciable extent within 24 hours, or as soon as the first thin layer of graphite is deposited. The increase of loss when the pressure rises is very manifest.

On the whole, the small variations of pressure actually observed in normal working are of no importance; but obstruction both detains the gas in the heat and exaggerates the loss due to porosity of the retort walls.

The Market for Gas Securities.

The city gas share market during the week was steady to strong, the former remark applying to Consolidated, which barely held its own at or about the par mark. Transfers were on a smaller scale than those of the week previous, and there seems to be a settled feeling now that the dividend rate will not be increased this half. After the dividend of June last was declared, the stock sold "ex." at 96. Remembering this, the investment value of the shares has apparently increased in the six months, according to current quotations—100-100¼—1½ per cent. Mutual and Equitable are strong, and Standard is about as before. We have more rumors about a possible further consolidation of the gas interests of New York, and, in fact, the only bar to such an agreement is the excessive capitalization of the Standard Company—that is, it is difficult to cause holders of other shares to accept the estimate of the Standard's property, as figured out by the latter's owners.

Brooklyn shares show no particular change in values, old Brooklyn being in demand at 103 ex-dividend of 2 per cent., which is payable now. This is the first return on old Brooklyn stock made in the past year, but this resumption would seem to place the Company in the regular lists again. It likely will pay at least 6 per cent. in the next twelvemonth. Chicago gas is strong at 57½ to 57¾. Baltimore is stronger, at 45¼ to 45¾.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,

16 Wall St., New York City.

November 9.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	99½	100
Central	500,000	50	—	90
" Scrip	220,000	—	95	100
Equitable	4,000,000	100	120	123
" Bonds	1,000,000	—	106	108
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	110	115
Mutual	3,500,000	100	119	121
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	—	—
" Bonds	150,000	—	—	100
Standard Gas Co—				
Common Stock	5,000,000	100	40	45
Preferred	5,000,000	100	—	82
Yonkers		50	112	—
Richmond Co., S. I.	346,000	50	—	—
" Bonds	20,000	—	—	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	102	105x
Citizens	1,200,000	20	—	80
" S. F. Bonds	320,000	1000	—	103
Fulton Municipal	3,000,000	100	112	115
" Bonds	300,000		102	—
Peoples	1,000,000	10	62½	67
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	100	—
Metropolitan	870,000	100	90	95
" Bonds (5's)	70,000	—	100	—
Nassau	1,000,000	25	120	—
" Ctfs	700,000	1000	100	—
Williamsburgh	1,000,000	50	107	110
" Bonds	1,000,000	—	106	—
Out of Town Gas Companies.				
Boston United Gas Co.—				
1st Series S.F. Trust	7,000,000	1000	84	86
2d " " "	3,000,000	1000	70	74
Bay State Gas Co.—				
Stock	5,000,000	50	—	56
Income Bonds	2,000,000	1000	98	102
Buffalo Mutual, N. Y.	750,000	100	105	110
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	155	160
" " Bonds	45,000	—	—	—
Chicago Gas Company	25,000,000	100	57½	57¾
Chicago Gas Light & Coke Co.—				
G't'd Gold Bonds	7,650,000	1000	82	82½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1000	—	97½
People's Gas and Coke Co., Chicago—				
1st Mortgage	2,100,000	1000	—	100
2d "	2,500,000	1000	—	100½
Consumers Gas Light Co., Jersey City	2,000,000	100	12	15
Bonds	600,000	1000	70	75
Cincinnati G. & C. Co.	7,000,000	100	—	200
Consumers Toronto	1,000,000	50	169	172
Central, S. F., Cal			90	—
Capital, Sacramento, Cal			58	
Consolidated, Balt.	11,000,000	100	45½	45¾
" Bonds	6,400,000		107	107½
Citizens Gas Lt. Co., Rochester, N. Y.	500,000	—	85	110
Bonds	250,000		—	—
East River Gas Co., Long Island City	1,000,000	100	100	105
Bonds	500,000	100	100	102
Hartford, Conn	750,000	25	109	114
Jersey City	750,000	20	180	200
Louisville, Ky	2,570,000	50	125	130
Little Falls, N. Y.	50,000	100	—	106
" Bonds	25,000	—	100	103
Laclede Gas Light Co., St. Louis, Mo.—				
Common Stock	7,500,000	100	18¼	19¼
Preferred "	2,500,000	100	—	—
Bonds	9,034,400	1000	77½	78
Montreal, Canada	2,000,000	100	200	208
Memphis (Tenn.) Gas	750,000	100	40	—
" Bonds	240,000	100	103	—
New Haven, Conn		25	200	—
Oakland, Cal			34¾	35¼

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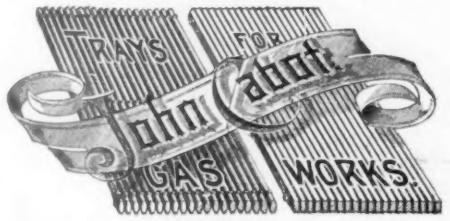

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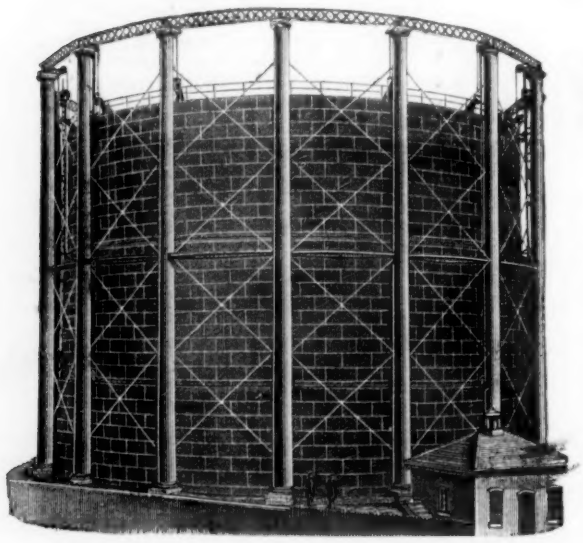

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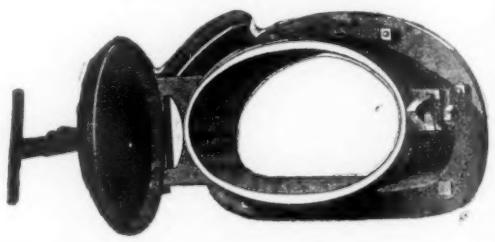

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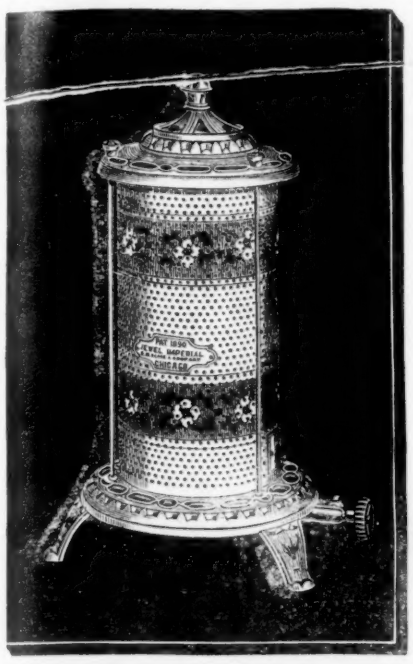

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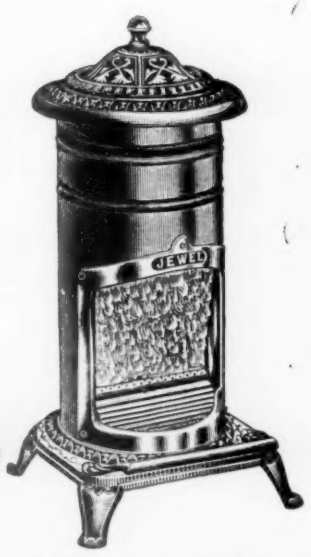

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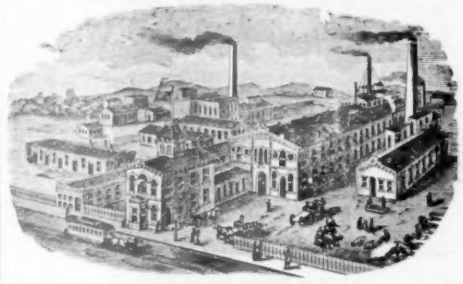

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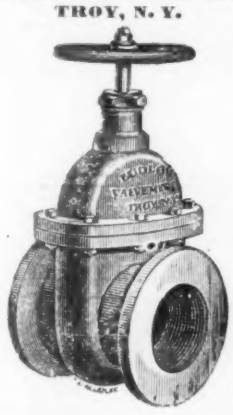

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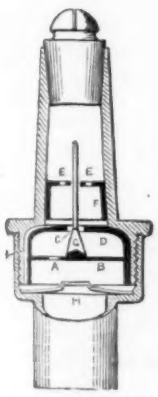

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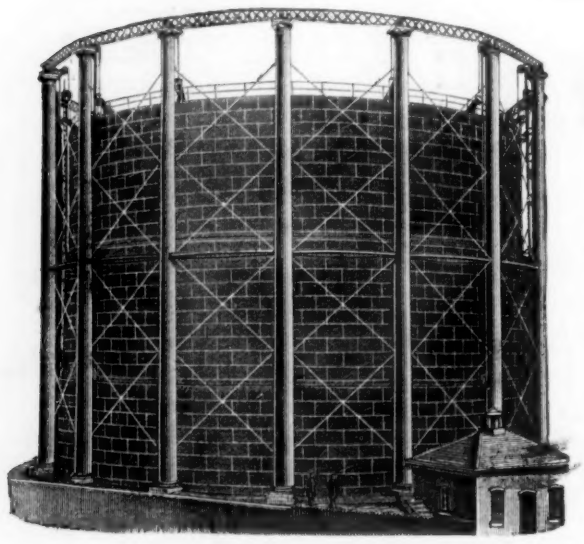

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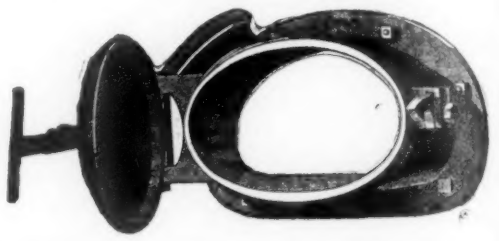

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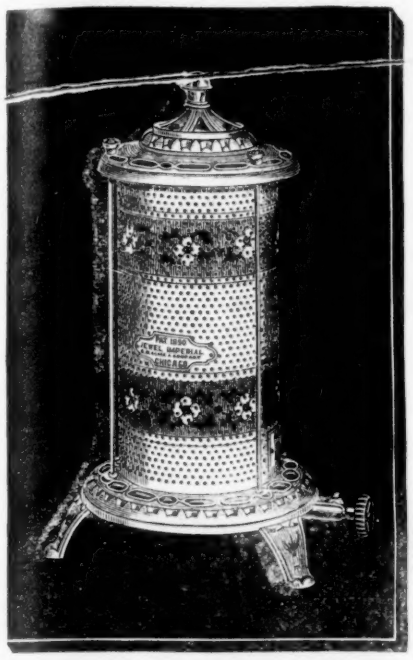

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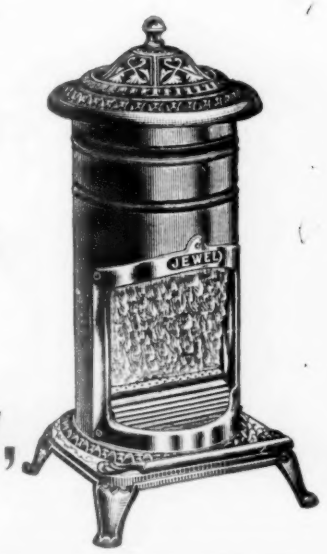

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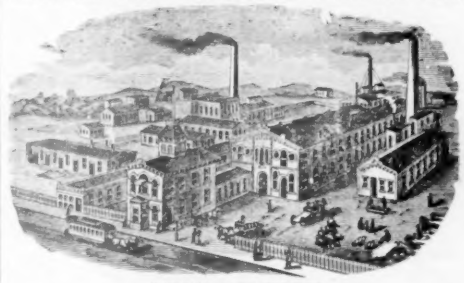

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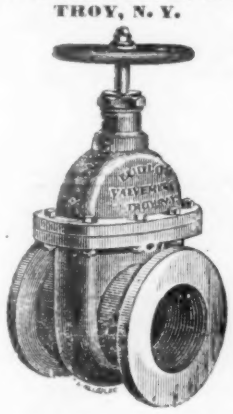

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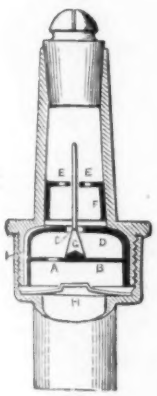

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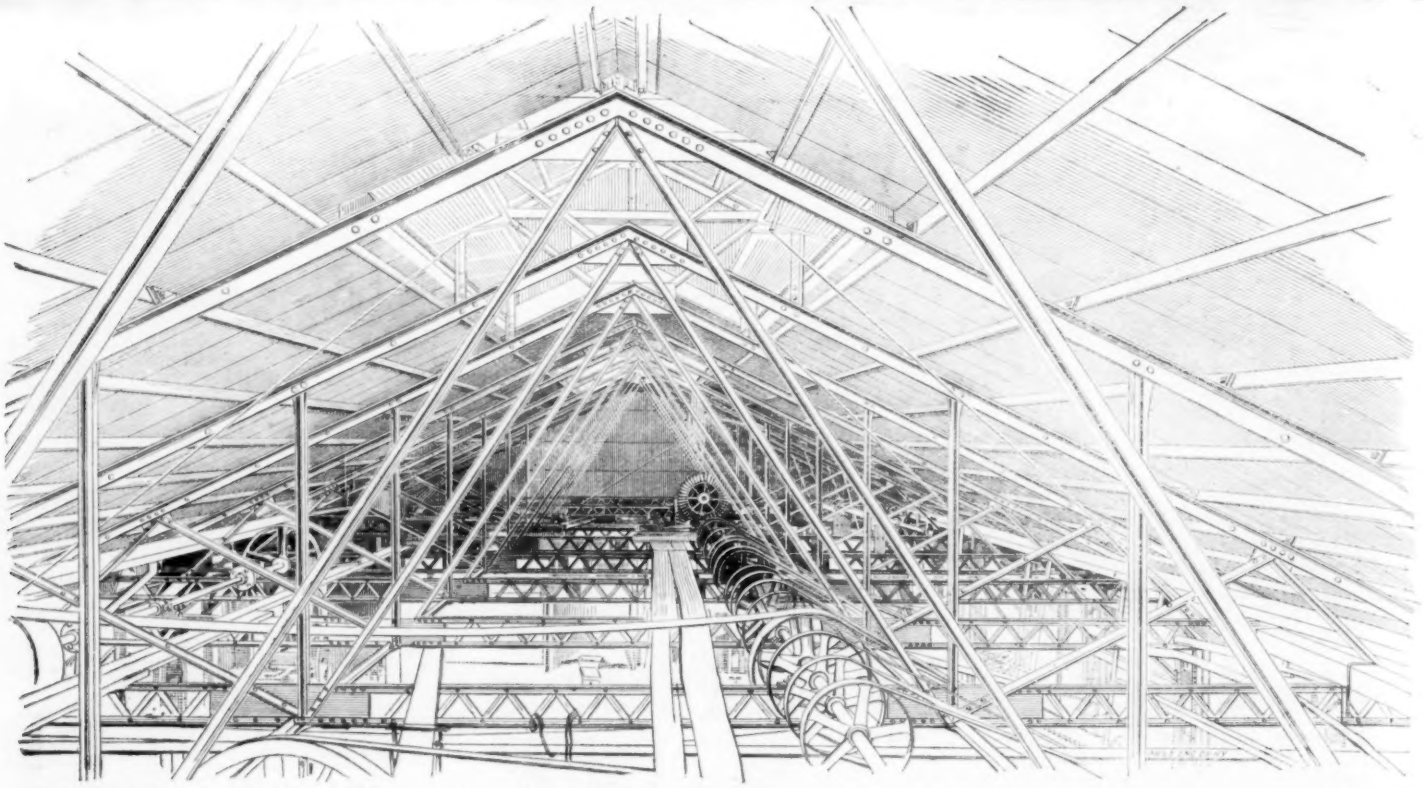

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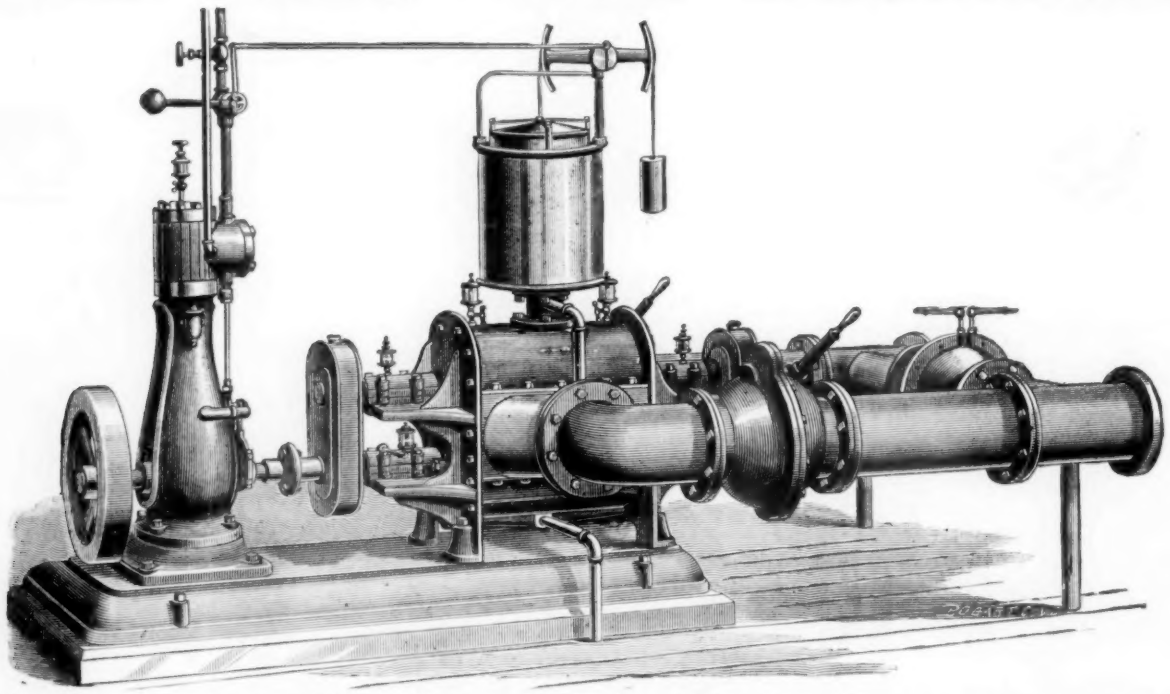

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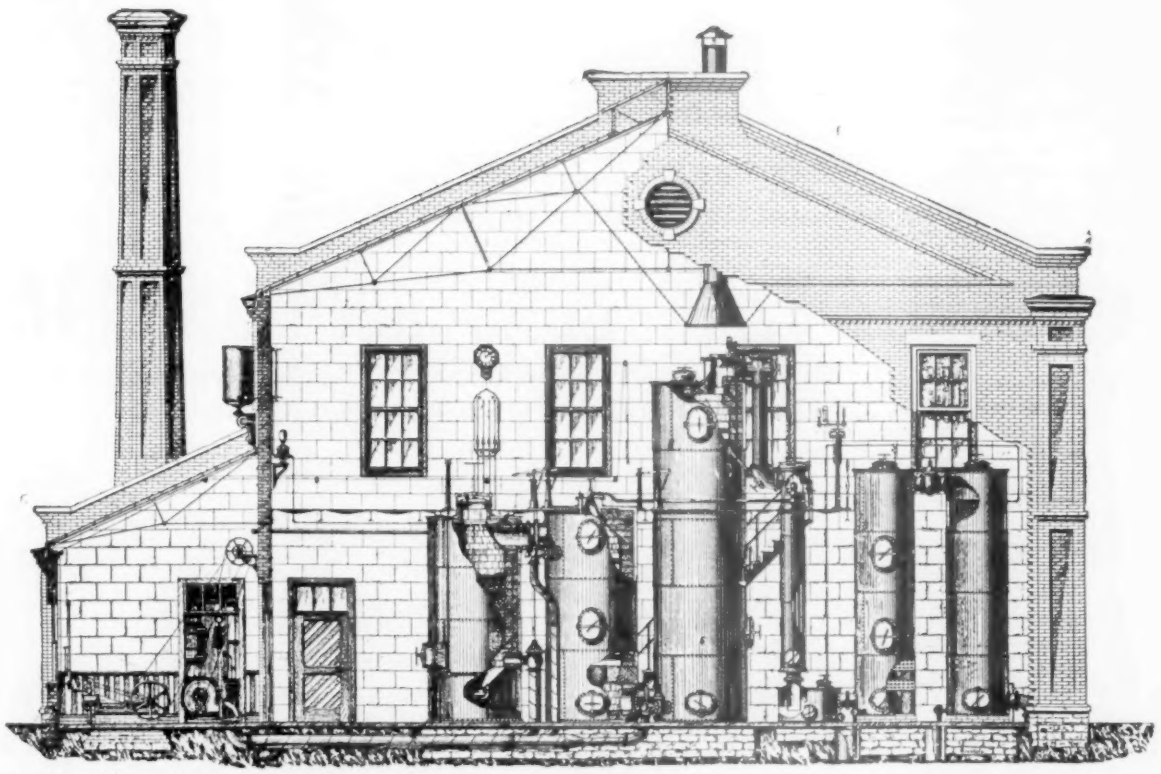

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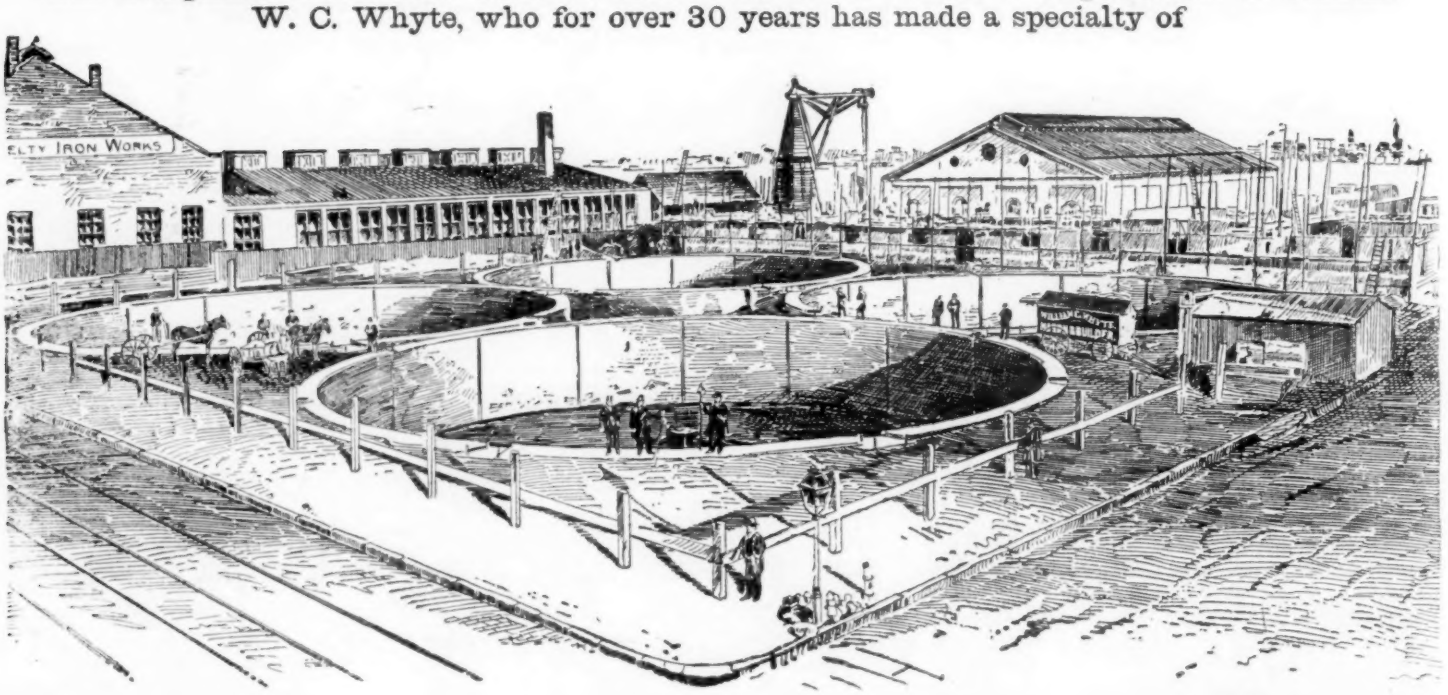

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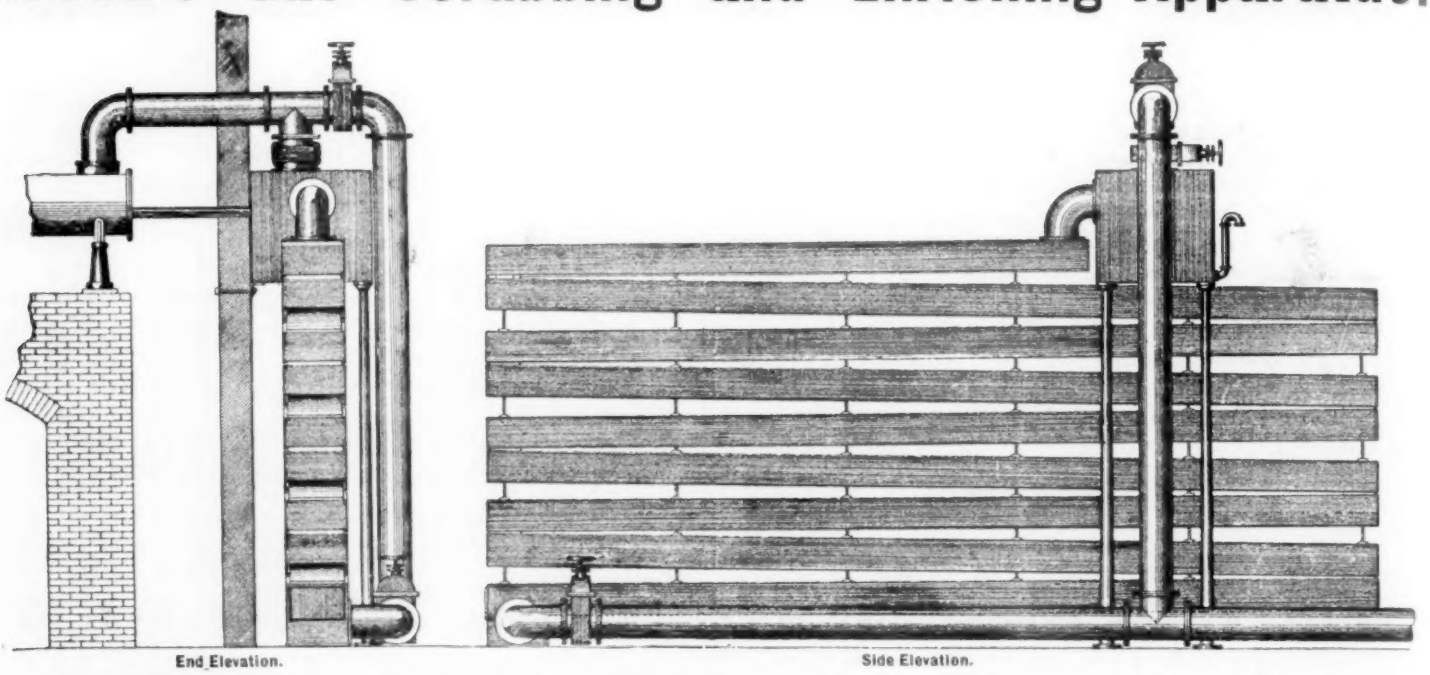

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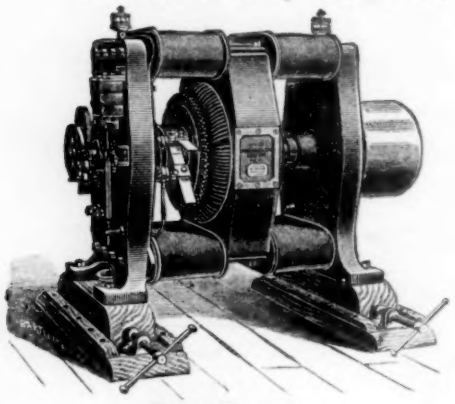

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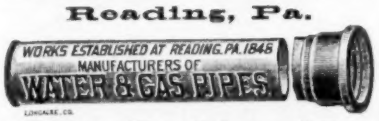

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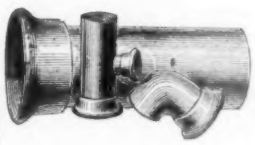

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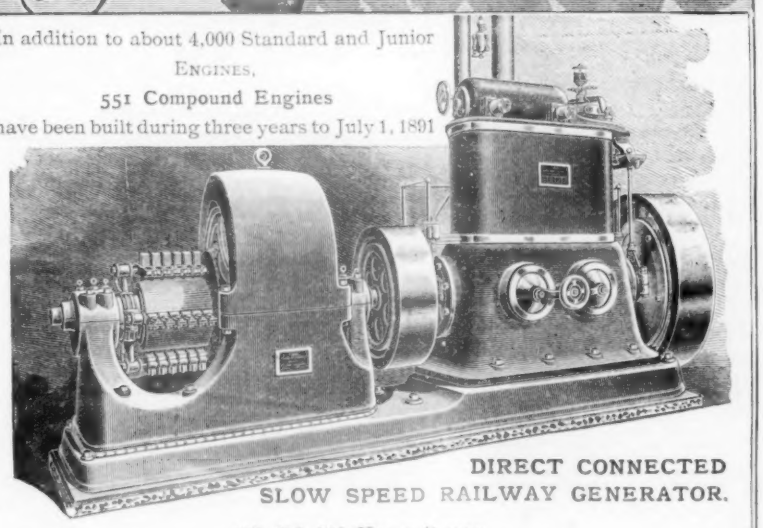

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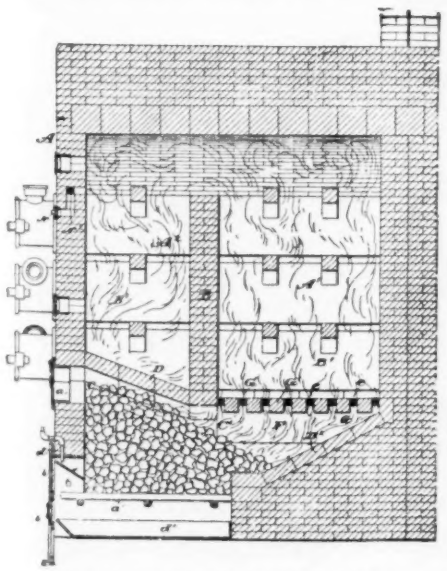

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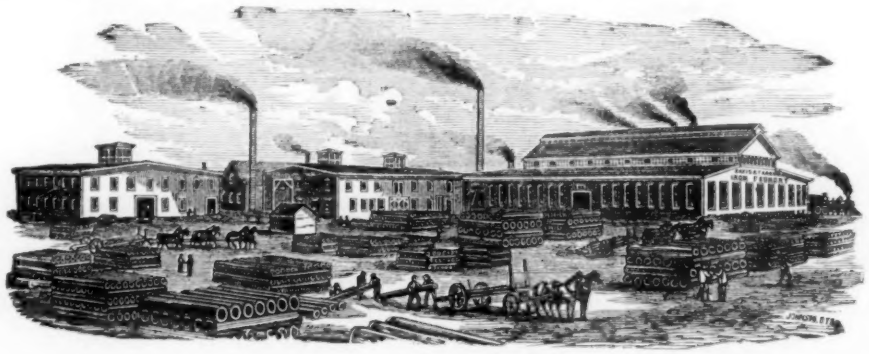

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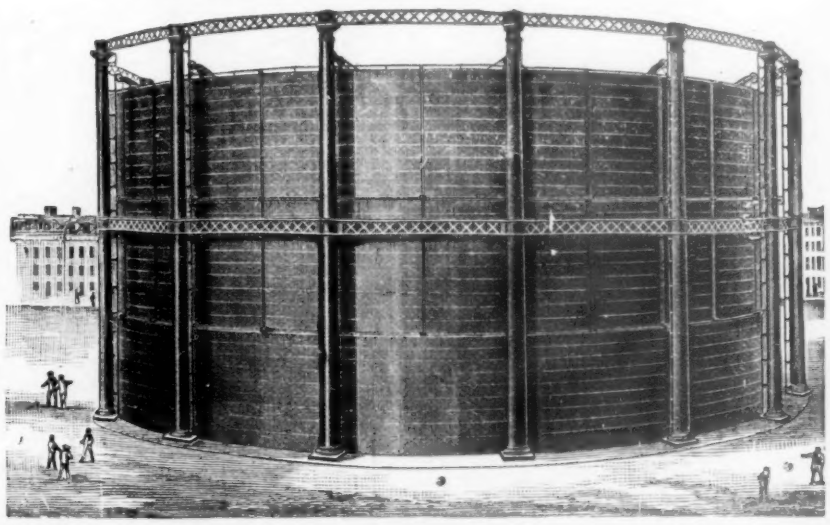

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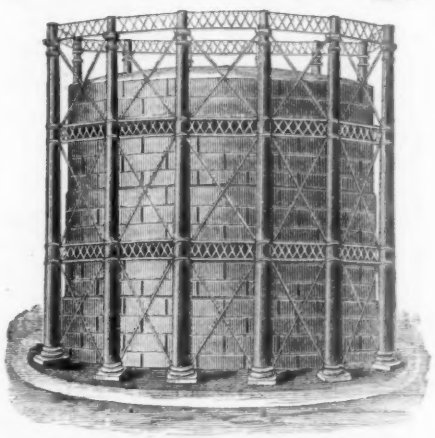

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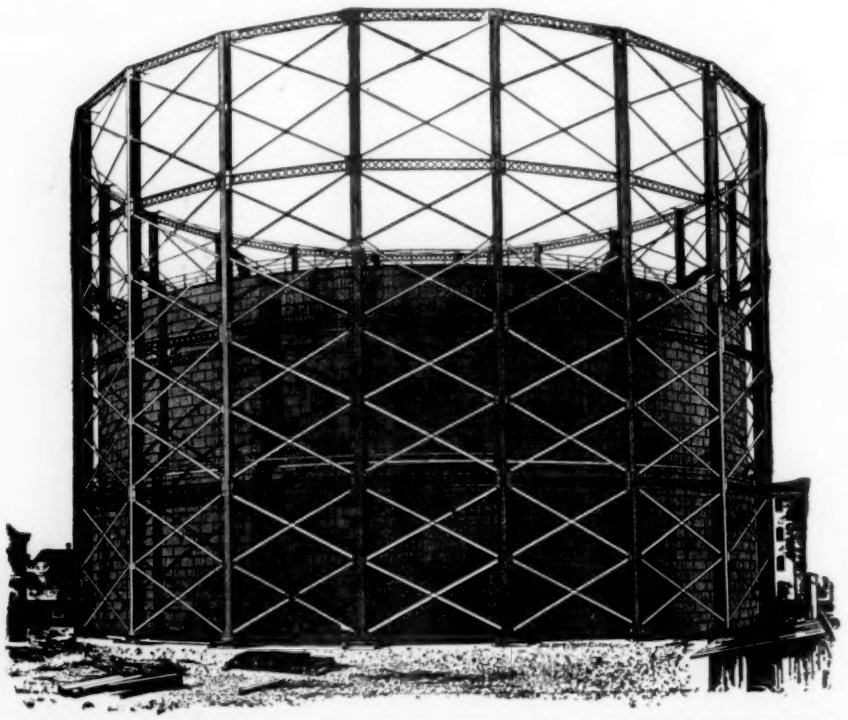

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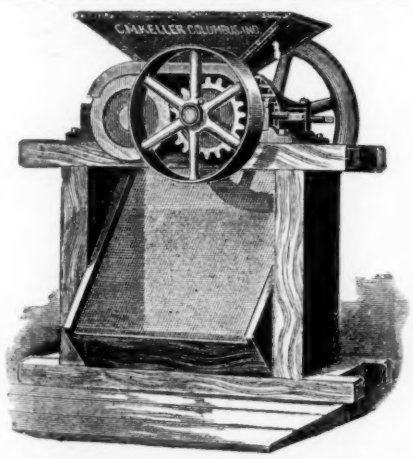

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